FINAL WORK PLAN
REMEDIAL DESIGN ACTIVITIES
SITE-WIDE GROUNDWATER
EXTRACTION AND TREATMENT SYSTEM

TUTU WELLS SITE
ST. THOMAS, U.S.V.I.

Volume I

April 22, 1998

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WORK ASSIGNMENT NO.: 088-2R1D
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PREPARED FOR:

U.S. Environmental Protection Agency
290 Broadway
New York, New York 10278

PREPARED BY:

CDM FEDERAL PROGRAMS CORPORATION
125 Maiden Lane, Fifth Floor
New York, New York 10038

REMEDIAL DESIGN ACTIVITIES
AT SELECTED UNCONTROLLED
HAZARDOUS SUBSTANCE DISPOSAL SITES
IN REGION II
(ARCS II)

U.S. EPA CONTRACT NO.: 68-W9-0024

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Prepared by: _____ Date: 4/22/98
Drew Bennett
Work Assignment Manager

Reviewed by: _____ Date: 4/22/98
Jeanne Litwin
Technical Operations Manager

Approved by: _____ Date: 4/22/98
Robert D. Goltz, P.E.
ARCS II Program Manager

Remedial Design Activities
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St. Thomas, U.S.V.I.

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1.0 GENERAL

1.1 INTRODUCTION

CDM Federal received Work Assignment 088-2R1D from the US Environmental Protection Agency (EPA) to provide remedial design services for the site-wide groundwater extraction and treatment remedy at the Tutu Wells Site in St. Thomas, U.S. Virgin Islands.

The purpose of this remedial design (RD) is to design a groundwater pump and treat system to control the groundwater sources of contamination and to reduce or minimize the migration of contaminants at the Tutu Wells Site, St. Thomas, US Virgin Islands (USVI) as documented in the EPA's Record of Decision (ROD) dated August 5, 1996. CDM Federal will conduct the RD in accordance with EPA's Remedial Design/Remedial Action Handbook, dated June 1995, the EPA Guidance on Expediting Remedial Design Remedial Action, dated August 1990, and other appropriate guidance. One objective of the design will be the generation of performance-based specifications for the construction of the treatment system.

1.2 BACKGROUND

The information below briefly summarizes the characteristics of the site that are relevant to the design of the groundwater remedy. For greater detail concerning the physical characteristics, the demographics, site history, and nature and extent of contamination, please refer to the Remedial Investigation Report (Geraghty and Miller, Inc. 1995) and other site characterization documents.

1.2.1 Description of Site

The Tutu Wells Site (Figure 1) is located at the eastern end in the Anna's Retreat Section of St. Thomas, within the upper Turpentine Run surface drainage basin. The basin, which covers approximately 2.3 square miles, trends roughly north-south and is bounded by the steep slopes of the surrounding hills. Adjacent valleys trend northeast-southwest or northwest-southeast. Paved two-lane roads (Route 384, Route 38, and Highway 382) run down the valley axes. These roads are lined by a variety of commercial establishments, schools, and churches. Private homes and multi-family housing units line the less heavily traveled side roads. According to the 1990 U.S. Census Bureau data, approximately 9,100 people live in Anna's Retreat (also known as the Tutu Subdistrict of St. Thomas). This represents approximately 20 percent of the island's population.

The site is underlain by moderately weathered, fractured volcaniclastic rock of the Water Island and Loisenhoj Formations and, locally, the Cabes Point Conglomerate. This bedrock is exposed on the hills, steep slopes, and on road cuts. On gentle slopes of hills, and in the valley axes, the bedrock is overlain by thin, unconsolidated deposits of stream-transported sediments, consisting of poorly sorted mixtures of clay, silt, sand, gravel, cobbles, and boulders. These colluvial/alluvial deposits are generally only 2-4 feet thick, but locally reach thicknesses of 10 to 30 feet in the valley axes. Beneath the paved roads and in the commercially developed central part of the valley, artificial fill

has been brought in to level the area. Thickness of the unconsolidated overburden (natural and artificial) varies from approximately 5 to 30 feet in the area of Four Winds Plaza and the Esso Service Station.

The fractured volcanic rocks form a significant unconfined aquifer, hereafter called the Turpentine Run Aquifer, which supports a number of private and commercial water supply wells. This aquifer was previously the largest fresh water supply on the island. However, since 1987, many of the public and private supply wells within the Tutu Wells site have been closed due to contamination. Groundwater in the Tutu Aquifer is stored and transmitted through fracture sets (faults, joints, and bedding planes). The major fracture sets control the surface topography, and can be noted in maps and air photos as structural lineaments. Groundwater flow at the Tutu Wells Site is to the south and southeast from the highland areas (recharge zones) towards the lower Turpentine Run basin (discharge zone). The surficial alluvial deposits, where saturated, form a secondary aquifer of lesser significance due their limited thickness and lateral extent. The alluvial aquifer is in direct hydraulic communication with the bedrock aquifer, although local perched water conditions may exist at the top of bedrock.

The Turpentine Run itself is an intermittent stream. Surface-water runoff in the Upper Turpentine Run is collected in a storm-water catchment system. Storm water and secondary sewage discharge into the Turpentine Run in the area separating the Upper Turpentine Run from the Lower Turpentine Run. The Run is partially channelized and ultimately discharges into Mangrove Lagoon and the Caribbean Sea. Wetland areas are found in the Lower Turpentine Run. A wetland of potential significance to the groundwater remedy is located along Highway 32 near the 1994 leading edge of the contaminated groundwater plume.

1.2.2 Site History

On or about July 7, 1987, Mr. Eric Tillet contacted the Department of Planning and Natural Resources (DPNR) regarding an odor emanating from the raw well water on his property located at Anna's Retreat.

On July 16, 1987, EPA received a request from the DPNR in St. Thomas, for sampling and analysis of several wells in the Tutu area. On July 21, 1987, EPA and its Technical Assistance Team (TAT) contractor, Roy F. Weston, Inc., mobilized to St. Thomas to sample the drinking water wells suspected of being contaminated. The test results showed the presence of high concentrations of gasoline and chlorinated organic compounds. Seven wells (Eglin, Four Winds, Harthman, and Virgin Islands Housing Authority) were closed down by order of the DPNR due to high volatile organic compound (VOC) concentrations.

Several of the wells in this area are large commercial wells used for public drinking water supply; therefore, the incident was classified as major, and the DPNR Commissioner requested EPA to assume the role of lead agency.

Sampling of cisterns served by the contaminated wells was also performed. EPA directed the Emergency Response Cleanup Services (ERCS) contractor to clean and disinfect the five (5) cisterns which had tested positive for tetrachloroethene (PCE), modify the existing home plumbing, disconnect the contaminated wells, and dispose of the contaminated water. At EPA's direction, the ERCS contractor also contracted with a local water hauler to deliver uncontaminated drinking water to the cisterns by tank truck. A well sampling program was established by EPA to monitor the wells at the Tutu Site.

A Hazard Ranking System Package was prepared and the Site was proposed to the National Priorities List (NPL) in February 1992. It was listed on the NPL on September 29, 1995.

The Remedial Investigation/Feasibility Study of the site soils and groundwater was performed by the Tutu Environmental Investigation Committee (TEIC), consisting of Texaco Caribbean, Inc. (Texaco) and Esso Standard Oil, U.S.A., Inc. (Esso). The results of these investigations are presented in Technical Memorandum I (Geraghty and Miller, April 1992), technical Memorandum II (Geraghty and Miller, May 1993), Final Phase II Remedial Investigation Report (Geraghty and Miller, April 1995), and the Draft Final Feasibility Study (Geraghty and Miller, August 1995). The RI/FS documented the existence of two petroleum-related groundwater contaminant plumes and several chlorinated VOC plumes in the Turpentine Run Aquifer (Figure 1). The various plumes overlap to form a composite plume of groundwater contamination that is elongated in the direction of groundwater flow.

The ROD was signed on August 5, 1996; it calls for area-wide plume/source containment and treatment of contaminated groundwater. Soils that are sources of groundwater contamination will be addressed at the various impacted facilities by a combination of in-situ and ex-situ soil vapor extraction and disposal of contaminated soils. Separate source control programs are underway at the Texaco and Esso service stations to remediate soils and to contain the spread of contamination from these facilities in groundwater.

The selected remedy for groundwater at the Tutu Wells sites includes the following components:

- Decommissioning of existing domestic and commercial wells within the confines of the groundwater plume, if these wells are determined to interfere with the operation of the groundwater pump and treat remedy;

- Institutional controls to prohibit unauthorized use of groundwater or the installation of new wells;

- Implementation of Source Control Programs (consisting of installation and operation of extraction wells and air strippers) at the Texaco and Esso Service Stations to address impacted groundwater in the immediate vicinity of these facilities.

- Installation of groundwater recovery wells for hydraulic control of plume migration. (The containment program proposed in the ROD includes the installation of three recovery wells [RW-1, RW-2 and RW-3]).

- Installation of groundwater recovery wells for hydraulic control of chlorinated VOC contaminant sources. (The ROD proposed two wells - RW-4 and RW-5). The source containment will provide hydraulic barriers around source areas, allowing the reduction of contaminants in other parts of the aquifer and potentially reducing the time needed to reach Maximum Contaminant Levels (MCLs).

- Construction of a groundwater treatment facility(s) with an estimated total flow capacity of 100 gallons per minute (gpm). Per the ROD, extracted groundwater will be treated to surface water criteria for discharge to the storm sewer leading to Turpentine Run, or other suitable discharge location. The final selection of the discharge option, which is to be decided in consultation with the Virgin Islands Government, was deferred to the remedial design stage.

- Semi-annual collection of groundwater samples during the operational life of the groundwater extraction remedy to monitor water quality and contaminant migration at or near the plume boundary.

- Natural attenuation of low concentration contaminants at the plume edges and downgradient of recovery wells R2 and R3.

A numeric cutoff for groundwater capture was never specified in the FS. However, the proposed extraction wells were located to capture groundwater with >100 parts per billion (ppb) total VOCs. Groundwater <100 ppb total VOCs would be remediated by natural attenuation. To capture water <100 ppb TVOCs in this fractured bedrock aquifer, a very large quantity of clean water would also need to be captured, which would dilute the influent significantly.

1.2.3 Summary of Previous Groundwater Investigations and Results

During the Phase I RI, groundwater samples were collected from 19 monitoring wells in the Tutu area. During the Phase II RI, the study was expanded to the south and a comprehensive round of groundwater samples was collected from 51 monitoring wells and 15 supply wells in the Tutu Valley. These samples were analyzed for organic compounds, metals, and various inorganic water quality parameters. In addition, eight rounds of groundwater supply well samples were collected and analyzed during the RI. The groundwater sampling results indicated the presence of four main plumes of contamination at the Tutu Wells Site: two chlorinated VOC plumes (northern and southern) and two benzene, toluene, ethylbenzene, and xylene (BTEX) (Texaco and Esso) plumes.

Chlorinated VOC Plumes

Two major sources of chlorinated VOCs have been identified; LAGA/Curriculum Center and O'Henry. While the plumes from these sources have co-mingled, they can nonetheless be distinguished based on concentration levels. The northern chlorinated VOC plume, which originates near the Curriculum Center, extends approximately 1,600 feet south, in the direction of the groundwater flow, to a point just southeast of Four Winds Plaza, and is approximately 500 feet wide. The highest concentrations of total chlorinated VOCs occur in shallow zone monitoring wells near the source, where chlorinated VOC concentrations greater than 1,000 ppb were detected. Concentrations of VOCs in the northern part of the north plume have not decreased with time, nor have the shape or general extent of VOC contamination changed in this area suggesting that there is a continuing source of VOCs to groundwater in the vicinity of the Curriculum center.

The principal chlorinated VOCs detected in the northern plume are 1,2-dichloroethene (DCE), PCE and trichloroethene (TCE). Vinyl chloride has also been detected at high concentrations in the northern plume, but its detection was restricted to the immediate vicinity of the Curriculum Center. The maximum concentrations detected in the northern plume during the RI were 1,2-DCE at 2,100 ppb, vinyl chloride at 1,300 ppb, PCE at 360 ppb and TCE at 78 ppb. The Safe Drinking Water Act MCLs for 1,2-DCE, PCE, TCE and vinyl chloride are 70, 5, 5, and 2 ppb, respectively.

Historically, the concentration of PCE in the Tillet supply well, located downgradient of the Curriculum Center, has been reported up to 2,040 ppb, which exceeds 1 percent of the solubility of PCE. Dense non-aqueous phase liquids (DNAPLs) are therefore suspected to be present in this vicinity. The maximum concentrations of 1,2-DCE and vinyl chloride in groundwater also strongly suggest the presence of chlorinated DNAPL in the vicinity of the Curriculum Center.

In the southern part of the northern chlorinated VOC plume, south of Tillett Gardens, VOC concentrations are generally lower than they are near the Curriculum Center. The highest concentrations of VOCs detected in this part of the plume during the RI were PCE at 140 ppb, 1,2-DCE at 100 ppb and TCE at 33 ppb. Unlike the northern part of this plume, VOC concentrations in the southern part of the plume are greater in deeper monitoring wells than they are in the shallow wells. Low levels of chlorinated VOCs were also detected in soils at the Esso Tutu Service Station. These soils may be contributing some chlorinated VOCs to the southern portion of the northern plume. However, there is no evidence of DNAPL contamination at ESSO.

The southern VOC plume originates near the O'Henry Dry Cleaners and extends southeast approximately 4,000 feet, to a location past the Delegarde well. It is approximately 800 feet wide. In the shallow zone, the highest total concentration of VOCs detected in 1994 was 181 ppb in a monitoring well just downgradient of O'Henry Dry Cleaners. In the deep zone, total chlorinated VOCs were detected above 100 ppb in several private supply wells. The chlorinated VOCs detected in the southern plume consist primarily of PCE, TCE, and 1,2-DCE above MCLs, with PCE contributing about 75 percent of the total chlorinated VOCs detected in wells near the O'Henry Dry

Cleaners. The historical presence of PCE at concentrations in excess of 1,500 ppb in wells adjacent to the O'Henry facility suggests the possible presence of DNAPLs in the saturated zone.

BTEX Plumes

Based on the RI data, the BTEX plume located near the Texaco station is approximately 400 feet long from north to south, in the direction of shallow groundwater flow, and approximately 200 feet wide from east to west. The dimensions of the plume decrease with depth; based on deep monitoring well data the plume is approximately 300 feet by 130 feet in areal extent. During the RI sampling, the maximum concentration of benzene detected was 21,000 ppb, ethylbenzene was 3,700 ppb and xylenes were 18,000 ppb. The MCLs for benzene, ethylbenzene and total xylenes are 5, 700 and 10,000 ppb, respectively.

The BTEX plume located near the Esso Tutu Service Station, as identified by monitoring well data during the RI, measures approximately 250 feet by 175 feet. The maximum concentration of benzene detected at this location was 10,000 ppb, ethylbenzene was 4,100 ppb and total xylenes was 22,000 ppb, all of which exceed their respective MCLs.

The presence of floating petroleum product and sheens in some monitoring wells at the Esso Tutu and Texaco Tutu Service Stations confirmed the presence of light non-aqueous phase liquids (LNAPL) at the two gas stations.

1.3 OUTLINE OF WORK

The work to be performed for this assignment falls under two main categories: predesign investigations and design. Prior to designing the groundwater extraction/treatment system, additional information is needed concerning the current levels and distribution of contaminants in site groundwater and the hydraulic characteristics of the aquifer. CDM Federal will perform the following predesign work:

Groundwater sampling - The most recent groundwater data delineating the contaminant plumes is from 1994. CDM Federal will sample existing monitoring wells and supply wells to ascertain the current position of the VOC and BTEX plumes and the current chemical concentrations. The exact depths of the contaminant plumes were not determined during the RI. This data gap will be addressed during predesign by geophysical logging and discrete sampling of packered intervals in existing open-hole supply wells.

Aquifer testing - In order to determine the aquifer response to pumping and to derive site-specific hydraulic transmissivity and conductivity values, CDM Federal will conduct two aquifer tests, pumping new recovery wells at or near the proposed groundwater extraction locations.

Groundwater modeling - Groundwater flow modeling will be conducted to support the selection of extraction well locations and pumping rates. The model will also be used to estimate hydrologic impacts to the downgradient wetland boundary under various extraction/discharge scenarios and to estimate whether these scenarios have the potential to induce upconing of saline formation water into the Turpentine Run aquifer. Screening-level contaminant transport modeling will be performed to predict the time for natural attenuation of contamination to MCLs to occur at the plume edges (see Subtask 3, Section 2.3).

Wetland delineation - The wetlands in the vicinity of Mt. Zion at the southern end of the southern VOC plume, will be delineated. Water levels from new monitoring wells and piezometers installed in the vicinity of the wetland area will be measured during the aquifer test. In addition, a baseline of water levels in the wetland will also be established. The potential impact of groundwater extraction on the wetland hydrology will be evaluated during the groundwater modeling.

The wetland area at the mouth of Turpentine Run will also be delineated. Both wetlands will receive flora/fauna determinations as well as wetland functional analyses. A reference wetland will also be considered in the analysis. Surface water and sediment sampling of Turpentine Run will also be performed.

Install new monitoring wells - New wells will be installed in critical locations to be used during the aquifer testing and/or as long term groundwater monitoring points.

Treatability test - Bench-scale testing for naturally occurring metals removal will be performed to determine effective treatment processes.

Geotechnical survey - limited soil sampling will be conducted at the selected treatment plant locations and possibly along the pipeline route.

During the early predesign stage, the USVI, together with EPA, must decide whether the treated groundwater will be used for any nonpotable purposes or simply discharged to the storm sewer. A feasible building site(s) for the groundwater treatment plant(s) must also be determined. To assist EPA and the USVI in these decisions, CDM Federal will prepare a discharge options analysis and facility siting analysis report.

The above activities will provide the design parameters needed to initiate the design phase of the RD. The design will include:

- Identification of access agreements, easements and permits;
- Preparation of preliminary, pre-final and final design reports;
- Preparation of a construction cost estimate;
- Preparation of performance-based request for proposal (RFP) preliminary, pre-final and final design documents;

- Preparation of preliminary and final monitoring plans;
- Preparation of a draft operations and maintenance manual;
- Provision of post-remedial design negotiation support; and
- Community Relations Support.

Section 2.0 describes in detail the tasks that will be performed for this work assignment. Figure 3 shows the project schedule. Table 1 lists the project deliverables that will be prepared by CDM Federal and gives the schedule for their submittal.

1.4 QUALITY ASSURANCE

All work on this work assignment will be performed in accordance with the following guidance documents:

- Remedial Design/Remedial Action Handbook, USEPA, Office of Emergency and Remedial Response, EPA 540/R-95/059, June 1995;
- Superfund Remedial Design and Remedial Action Guidance, USEPA, Office of Emergency and Remedial Response, OSWER Directive 9355.)-4A, June, 1986;
- Guidance on Expediting Remedial Design and Remedial Action, USEPA, Office of Emergency and Remedial Response, EPA /540/G-90/006, August, 1990;
- EPA Region II CERCLA Quality Assurance Manual, Revision 1, October 1989;
- CDM Federal ARCS Region II QA Management Plan (QAMP), Revision 4, April 19, 1995;
- CDM Federal Programs Corporation Quality Assurance Manual, Revision 8, October 30, 1997;
- CDM Federal Programs Corporation, Design Quality Control Plan, April 2, 1997; and
- CDM Federal Programs Corporation, Project Management Guide, Revision 1, January 1997.

The Regional Quality Assurance Coordinator, or her designee, has reviewed this work plan for quality assurance requirements and will maintain Quality Assurance (QA) oversight for the duration of the work assignment. A Sampling and Analysis Plan is required and will be submitted as part of the Quality Assurance Project Plan (QAPP). This QAPP will be subject to quality assurance review and approval following technical review.

The work assignment manager is responsible for implementing appropriate Quality Control (QC) measures on this work assignment. Such QC responsibilities include:

- Implementing the QC requirements referenced in the above guidances;
- Conducting field planning meetings;
- Adhering to the ARMIS document control system; and
- Organizing and maintaining work assignment files.

Technical review requirements in QAMP Section 5 will be followed on this work assignment. QA review requirements in QAMP Section 4.5 will be followed on this work assignment. Prior to conducting field activities, a field planning meeting will be held in accordance with the ARCS II QAMP. Any report presenting measurement data generated by CDM Federal during this work assignment will include a QA section addressing quality of data and its limitations. Such measurement reports will require a QA review following a technical review. An office internal systems audit or a field technical systems audit may be conducted by the CDM Federal QA staff. An audit report will then be prepared and distributed to the audited group, to CDM Federal management and to EPA. EPA may conduct or arrange a system or performance audit. CDM Federal may submit performance audit samples as required for non-RAS analyses.

2.0 TECHNICAL AND MANAGEMENT APPROACH

This section describes in detail the work to be performed for this remedial design. The work breakdown structure provided in EPA's statement of work is followed below.

2.1 TASK 1 - PROJECT PLANNING

This task includes all work efforts related to planning and administering this design project.

2.1.1 SUBTASK 1.1 - Work Plan Preparation

This task includes the project scoping meeting, a site visit, and preparation and negotiation of the draft and final remedial design work plans.

Scoping Meeting - The CDM Federal Work Assignment Manager and Program Manager attended a meeting at EPA on October 9, 1997, to discuss the scope and schedule of the work assignment.

Site Visit - Accompanied by the EPA Remedial Project Manager (RPM), the project design engineer and project hydrogeologist/predesign investigation leader visited the site in St. Thomas, USVI to become familiar with site conditions and to initiate discussions with the USVI DPNR concerning the discharge options for treated groundwater. Due to schedule constraints, this visit occurred between the submittal of the draft and final work plans.

Draft RD Work Plan Volume I and Volume II (Cost Estimate) - CDM Federal prepared a draft work plan which described in detail the work to be performed during the RD in accordance the Remedial Design/Remedial Action Handbook, dated June 1995, the Guidance on Expediting Remedial Design Remedial Action, dated August 1990 and other appropriate guidance. The cost estimate to perform this work was presented in a separate Volume II.

Negotiation and Preparation of Final Work Plan Volume I and II - The CDM Federal WAM, Program Manager, Technical Operations Manager, and Senior Engineer attended a meeting at EPA to negotiate the Work Plan cost estimate. Based on the comments received from EPA, CDM Federal has prepared a Final Work Plan Volume I (this document) and Volume II.

2.1.2 SUBTASK 1.2 - Review Background Documents

The work assignment manager, project design engineer and project hydrogeologist/predesign investigation leader will review relevant background documents and evaluate existing data to develop a conceptual understanding of the site. Documents to be reviewed include the Final RI Report, the Final FS Report, EPA's Record of Decision, and other documents pertaining to regional hydrogeology and site-specific conditions.

2.1.3 SUBTASK 1.3 - Quality Assurance Project Plan

CDM Federal will prepare several plans to govern the predesign field investigations, including a QAPP, a Site Management Plan (SMP), and a Health and Safety Plan (HSP).

Quality Assurance Project Plan - The QAPP will describe the rationale for the field program. It will detail the following:

- Standard operating procedures (SOPs) for field investigations including sampling, monitoring, and field instrument calibration;
- Number, location, and types of samples;
- Parameters to be analyzed and analytical methods to be used;
- Chain-of-custody procedures;
- Sample packaging and shipment procedures;
- Decontamination procedures;
- QA/QC of field sampling and procedures for field changes and corrective action; and
- Responsibilities of site personnel.

The QAPP will be prepared in accordance with EPA Region II requirements. The QAPP requires information such as sample data quality objectives, detection limits, QC procedures related to sampling operations and laboratory testing protocols.

Site Management Plan - The SMP will describe site control procedures, site operations organization, and the corresponding field operations schedule.

The site control section describes how approval to enter the areas of investigation will be obtained, along with the site security control measures, and the field office/command post for the field investigation. The logistics of all field investigation activities are also described. The site operations section includes a project organization chart and delineates the responsibilities of key field and office team members. The last section includes the predesign RD schedule, showing the proposed scheduling of each major field activity.

Health and Safety Plan - the HSP will specify employee training, protective equipment, medical surveillance requirements, standard operating procedures and a contingency plan in accordance with 29 CFR 1910.120(l)(l) and (1)(2).

2.1.4 SUBTASK 1.4 - Quality Assurance

Quality assurance activities to be performed during this project may include field and technical systems audits, field planning meetings, and quality assurance reviews of all project plans, measurement reports and procurement packages. In addition, a project quality management (PQM) meeting will be held during the early stages of the project to identify critical factors for project success.

2.1.5 SUBTASK 1.5 - Project Administration

The project administration activity involves budget management and tracking, project scheduling and coordination, preparation of technical and financial status reports, and attendance at quarterly ARCS Project Manager meetings. This task also includes the Program Management Office (PMO) activities which consist of internal status/progress meetings, technical and financial reviews of the monthly reports, reviews of deliverables, staffing requirements, document control filing, transfers, invoices.

2.1.6 SUBTASK 1.6 - Project Closeout

Project close-out includes work efforts related to the project completion and closeout phase. Project records will be consolidated and transferred to EPA. A Work Assignment Closeout Report (WACR) will be completed.

2.2 TASK 2 - PREDESIGN FIELD INVESTIGATION

This task includes work efforts to collect the required data to support the RD. The approach adopted for the predesign field investigation includes environmental sampling, hydraulic testing, and modeling designed to meet the following specific objectives:

- refine/confirm previous estimates of the nature and extent of groundwater contamination in the Tutu Valley and Turpentine Run;
- collect the necessary data to complete the design for the groundwater extraction, treatment, and discharge system stipulated in the Record of Decision;
- collect the required data to support the groundwater modeling effort;
- address those data gaps and outstanding technical questions that remain after the RI/FS;
- identify potential downgradient receptors of defined contamination that will not be captured by the groundwater extraction system;
- assess the adequacy of existing wells for long-term monitoring in downgradient areas.

The predesign work will not include determination of waste quantities and boundaries of the source areas of groundwater contamination. This will be achieved under separate soil and source remedial actions at the various PRP facilities.

The data generated from the investigation will be used to support the implementation of the Record of Decision, satisfy data quality objectives (DQOs), and provide adequate information to evaluate appropriate remediation technologies.

2.2.1 SUBTASK 2.1 Site Reconnaissance

A site reconnaissance visit will be conducted to prepare for field work. Preparations include conducting an inventory of the status and condition of existing wells, siting the new monitoring and extraction wells, and evaluating candidate locations for groundwater treatment plant(s) and pipeline routes. CDM Federal will also meet with the USVI DPNR and the Water and Power Authority (WAPA) to discuss discharge options for treated groundwater, and obtain an overview of which wells have been decommissioned in the Tutu valley. The results may affect the sample locations proposed in this work plan.

2.2.2 SUBTASK 2.2 Mobilization/Demobilization

This subtask consists of property access assistance, field personnel orientation, equipment mobilization, and demobilization.

CDM Federal will seek the assistance of EPA and DPNR in obtaining property access permission from property owners within the study area, including upgradient well locations and access to properties along the Turpentine Run. Prior to field activities, each field team member will review all project plans and participate in a field planning meeting conducted by the CDM Federal WAM to become familiar with the history of the site, health and safety requirements, and field procedures. Team members will also attend a project kick-off meeting. Complete mobilization and demobilization will be performed for the two field events described in Section 2.2.3.

Equipment mobilization will entail ordering and purchasing of all equipment needed for each part of the field investigation. A complete inventory of available equipment will be conducted prior to initiating field activities. Any additional required equipment will be secured. This task also involves constructing a decontamination station for decontamination of sampling equipment. A separate decontamination pad will be constructed by the drilling subcontractor for drilling equipment.

Equipment will be demobilized at the completion of each field event, as necessary. Demobilized equipment will include sampling equipment, drilling subcontractor equipment, health and safety equipment, and decontamination equipment.

2.2.3 SUBTASK 2.3 Hydrogeological Assessment

The information obtained from the hydrogeological assessment will be used, in conjunction with the results from groundwater modeling described below, to determine the groundwater parameters needed to design the extraction and treatment remedy. These include:

- the current horizontal and vertical extent of the groundwater contaminant plumes,
- the horizontal and vertical component of groundwater flow and contaminant transport,
- the hydraulic characteristics of the aquifer in the areas of recovery or extraction,
- locations and specifications for the remedy extraction wells,
- the capture zone and pumping rates of the extraction wells, and
- influent water quality concentrations that will be received at the treatment plant.

The field activities described below have been planned to reduce logistical issues and to minimize mobilization costs. Two separate field events are proposed. The first consists of confirmatory sampling of existing monitoring and private supply wells, water level measurements, and wetland delineation. The second includes installation of monitoring wells, two extraction wells, aquifer testing, and groundwater sampling. Only the second field event will require the mobilization of any significant heavy equipment (e.g., drill rig).

2.2.3.1 Field Event I

The first field event includes activities that should be conducted immediately and can be carried out without the use of any heavy equipment such as drill rigs. Included are:

- comprehensive round of water level measurements to determine groundwater flow direction,
- groundwater sampling of existing monitoring and supply wells to determine the vertical and horizontal extent of groundwater contamination,
- wetland delineation to define wetland boundaries, and
- flow measurements of the Turpentine Run stream.

Each of these activities is described below.

Synoptic Water Level Measurements - Round I

A round of synoptic water levels will be collected during the first field event, to compare the current groundwater flow field against the RI/FS depiction of groundwater flow, as well as to provide a calibration data set for the basin-wide groundwater flow model. If possible, all wells within the Tutu aquifer basin will be measured, including wells upgradient of the site and downgradient within the Lower Turpentine Run. The number of wells measured will only be limited by access restrictions. This first measurement round will be completed prior to the first groundwater sampling event. Measurement procedures will be provided in the QAPP.

Groundwater Sampling - Round I

The last round of groundwater quality data was collected in 1994 as part of the RI/FS. Confirmatory sampling is needed at the onset of the predesign field work to:

- evaluate if site/plume conditions have changed appreciably since the RI;
- evaluate if the proposed remedial plan is still appropriate or will require modification;
- guide the installation of additional monitoring wells;
- estimate anticipated influent concentrations to the extraction and treatment system (see also Subtask 2.4, Section 2.2.4).

Thirty-one existing monitoring wells and 11 supply wells will be re-sampled to provide an update on the contaminant plume configuration and concentrations. Sampling will include the following existing monitoring wells and private/public supply wells along the Tutu Valley and Turpentine Run:

Private/Public Supply Wells	Existing Monitoring Wells
Delagarde, Matthias, Smith, LaPlace, Steele, Harvey, Eglin I or II, Tillett, Four Winds II, VIHA I, and Dench	MW-1, MW-1D, MW-2, MW-3, MW-4, MW-4D, MW-5, MW-6D, MW-7, MW-8, MW-9S, MW-10, MW-10D, MW-11D, MW-12D, MW-13D, MW-16, MW-18, MW-19, MW-20, MW-20D, MW-21D, MW-22D, MW-24, MW-25, DW-1, CHT-6D, CHT-7D, TT-3D, OHMW-4, and SW-6.

Samples will be analyzed for EPA Target Compound List (TCL) low-concentration VOCs and base/neutral/acid extractable (BNA) organic compounds, and Target Analyte List (TAL) metals. In addition, the following conventional water quality parameters will be analyzed to help assess contaminant fate and transport conditions: total dissolved solids (TDS), total suspended solids (TSS), nitrate/nitrite, sulfate, sodium, chloride, bromide, and carbonate/bicarbonate. Dissolved oxygen (DO), pH, and salinity, conductivity, turbidity and oxidation potential (Eh) will be measured in the field.

Eleven wells at the fringes of and upgradient from the plumes will be analyzed for additional parameters indicative of biodegradation activity (i.e., natural attenuation indicators): BOD, COD, hydrogen sulfide, methane/ethane/ethene, and total phosphate. Samples from the following wells will be analyzed for biodegradation parameters:

Private/Public Supply Well	Existing Monitoring Wells
Delagarde, Matthias, Smith, LaPlace, Steele, Dench, an upgradient well (e.g., Dimitri)	MW-1D, MD-10D, MW-21D, MW-22D

Sampling procedures and analytical methods will be detailed in the QAPP.

CDM Federal does not currently recommend sampling supply wells in the Rodriguez/KFC area, unless water level data collected in the southern VOC plume suggest that contamination emanating from this area will reach the groundwater extraction system. In that case, it may become necessary to collect additional samples during the second field event to evaluate expected influent concentrations of contamination from the Rodriguez area.

Wetland Delineation

Groundwater contamination with concentrations of total VOCs less than 100 ppb is currently flowing southeastward from the Tutu valley towards the Lower Turpentine Run. A wetland area exists at the southern end of the defined southern VOC plume (approximately 1,000 to 1,500 feet southeast of the Delagarde well). While the hydrology of this area is currently undefined, water levels could potentially be impacted by withdrawal of groundwater in the southern VOC plume, or by the addition of surface water if treated groundwater is discharged to storm or sanitary sewers, or directly into Turpentine Run. Therefore, CDM Federal will perform wetland delineation during the first field event as described in Subtask 2.7. In addition, water level monitoring, wetland function assessments and water and sediment sampling in Turpentine Run will be performed.

Turpentine Run Flow Measurements

To assist the evaluation of RD discharge options, and a general understanding of flow in Turpentine Run, flow measurements will be taken daily at three locations for the duration of the first field event. Flow estimates will be based on measuring flow velocities in the stream and multiplying those values by the cross-sectional area of Turpentine Run at each of the three measurement "stations". Flow velocities will be measured at three points along each cross-sectional section of the stream with a basic flow meter. If a significant storm event occurs during field activities, measurements will be taken more than once per day - before, during, and after significant rain events.

The three measurement locations will be selected during the site reconnaissance, but are expected to be sited between the existing sewage treatment plant and the wetlands along Route 32. CDM will also attempt to obtain daily discharge records from the treatment plant.

2.2.3.2 Field Event II

The second predesign field event will be more extensive than the first and includes drilling, well installation, groundwater sampling, hydraulic testing, and flow measurements of the Turpentine Run. A drilling subcontractor will be required for this event.

Drilling and Well Installation

During the second field event, eight new monitoring wells will be installed to supplement the existing monitoring well network. These wells will be used to better delineate the plume boundaries and to serve as observation wells during the aquifer test. Two of the five remedial extraction wells

will be installed during the predesign investigation and will be pumped during the aquifer tests to provide design parameters on aquifer/fracture zone conductivity, final pumping rates and influent concentrations. Final extraction well locations will be selected following an analysis of Round I water quality data, initial groundwater flow modeling, and field siting. The final locations of extraction wells and monitoring wells will be selected after consultation with EPA and DPNR.

The drilling and installation of monitoring and extraction wells is described under Subtask 2.4. The drilling of geotechnical borings is described under Subtask 2.6.

Borehole Geophysical Logging

One of the concerns with the planned RD extraction system is that total anticipated pumping in the Turpentine Run aquifer could exceed the sustainable yield of the system, particularly if uncontrolled and unmonitored pumping from private/public supply wells continues. The "safe" or sustainable yield of the aquifer system has been estimated at about 300,000 gallons per day (gpd) (Geraghty and Miller, 1983). The expected combined discharge of the RD extraction system alone is about 175,000 gpd. Unless private/supply well pumping can be regulated, there is a significant risk that the Tutu aquifer system will be overdrawn, which in turn could result in induced salinization by upconing of saline formation water from deeper parts of the bedrock.

To be able to monitor this potential upconing of saline formation water in the future, when the remedy extraction wells are pumping, the base-line salinity must be established. A second objective in determining the fresh/saline water interface is to minimize the capture of brackish or saline groundwater, which would then have to be treated to drinking water standards before discharge. To accomplish these objectives, geophysical (fluid conductivity) logging will be conducted in deep boreholes to determine if stratification of water is significant in the Tutu aquifer and to make sure saline water upconing will not be induced by the remedial pumping rates. The evaluation will be based on geophysical data and groundwater quality data from wells.

Following drilling of each borehole (monitoring well or extraction well), the length of each borehole will be logged geophysically using the following suite of tools:

- caliper (detects fractures);
- acoustic televiewer (detects fractures and orientation of fractures);
- TV camera (visual examination of borehole);
- fluid conductivity and temperature (detects inflow zones and water quality stratification- e.g., salinity); and
- flowmeter (provides an estimate of inhole flow rates).

Approximately 8 to 10 existing deep open hole supply wells (e.g. Eglin II) will also be logged. Site/well access may restrict the number of wells that can be logged.

Geophysical logs will be obtained from each well in order to record physical parameters that can be interpreted as characteristics of the rocks, the fluids in the rock (e.g., salinity and contamination), and in some cases, the construction of the well. Geophysical logging will cover the entire drilled depth, and will be performed in uncased, open boreholes. Detailed logging procedures will be provided in the QAPP.

Well Elevation Survey

Following installation, the elevation of the newly installed wells will be surveyed to provide accurate water level elevation data for the hydrogeological assessment and to support the groundwater modeling effort. The location and elevation of all wells installed during the RD will be surveyed by a licensed surveyor under subcontract to CDM Federal. CDM Federal will prepare a detailed scope of work as part of the process to procure a surveyor subcontractor. For each well, elevation data will be obtained for the top of inner and outer casing and ground surface.

Packer Testing

While the RI established the approximate lateral and longitudinal extent of contamination in the Tutu valley, it did not adequately define the depth of contamination. Some of the deep supply wells that were sampled are open hole or screened over 200 feet or more, and sample results provided in the RI may be representative of "diluted" water (i.e., water drawn from a large borehole column). To evaluate the depth of contamination in deep boreholes, and to identify whether contamination is flowing and entering these wells at discrete levels, packer testing will allow water to be pumped from discrete intervals within the boreholes to provide the following data:

- hydraulic head data versus depth;
- estimates of hydraulic conductivity versus depth; and
- water quality data versus depth.

The packer testing program will be conducted by the drilling contractor and will precede any drilling of RD extraction and monitoring wells. To the extent possible, the data will be used to select well depths for the RD extraction wells. For example, if packer testing of the Smith or Matthias wells suggests that contamination is restricted to the upper 100 feet of the saturated zone, then nearby extraction well RW-2 or RW-3 would be limited to this depth in an effort to optimize the extraction system operating conditions.

Up to six existing deep supply wells will be packer tested. Candidate wells are LaPlace, Eglin II or III, Smith, Four Winds I or II, Tillet, Harvey, and Dench. The final choice of wells will be determined by access restrictions.

The packer testing program will consist of sealing off 20-foot sections within each borehole and conducting limited pump tests or slug tests. A dual-packer assembly will be lowered to the bottom of each borehole and pumped for a period of about 1 to 2 hours. If appreciable quantities of water

cannot be extracted from a given interval, pumping will be abandoned, and a slug-injection test will be conducted instead. Following completion of testing of each interval, the assembly will be raised to the next level up. No more than 6 intervals in each borehole will be tested. Pressure transducers will be attached to the packer assembly, and will monitor head changes below, within, and above the dual packers. Manual measurements of water levels in nearby monitoring wells will also be taken, to test the hydraulic connectivity of these wells to the pumped zones. Static water levels will be measured prior to any testing.

During testing, water quality samples will be collected from each interval. Each sample will be analyzed for TCL low-concentration VOCs only. Detailed testing and sampling procedures will be provided in the QAPP.

Synoptic Water Level Measurements - Round II

A round of synoptic water levels will be collected to incorporate the new monitoring wells. This second measurement round will be completed prior to the second groundwater sampling event, and prior to any hydraulic testing. This data will benefit the modeling effort and interpretations of flow and vertical head gradients. Measurement procedures will be provided in the QAPP.

Groundwater Sampling - Round II

Following drilling and installation of the new monitoring and extraction wells, an additional round of groundwater sampling in select wells will be conducted. Round II sampling will include the eight new monitoring wells, the two new extraction wells and up to 10 existing wells that were sampled in Round I. Results will help refine the estimated extent of contamination, and partially confirm results obtained in Round I. The selection of existing wells to be resampled in Round II will be made after review of Round I data.

Samples will be analyzed for full TCL low-concentration VOCs and TAL metals. In addition, the following water quality parameters will be analyzed to help assess contaminant fate and transport conditions: TDS, TSS, nitrate/nitrite, sulphate, chloride, and carbonate/bicarbonate. DO, pH, salinity, conductivity, turbidity and oxidation potential (Eh) will be measured in the field. Select wells (6 maximum) will also be analyzed for biodegradation parameters, and will be decided upon after review of Round I data. Sampling procedures and analytical methods will be detailed in the QAPP.

Aquifer Testing in RD Extraction Wells

Aquifer tests will be conducted in each of the two extraction wells installed during the predesign field investigation. A step-drawdown test and a constant-rate test will be conducted in each well. The tests will be performed to determine well yields (Q), aquifer transmissivity (T), and to refine estimates of influent concentrations to be delivered to the proposed groundwater treatment system.

The durations and pumping rates of each test will be determined in the field and depend on site conditions. It is anticipated that the step-drawdown test will consist of 4 steps, each pumping at a higher rate than the previous, and each step lasting for one hour. Recovery between steps will not be allowed. Recovery will be measured after the last step-test. The constant rate aquifer tests will be conducted for a minimum 24-hour period, and will be followed by aquifer recovery. The duration of the constant rate tests is not expected to exceed 48 hours. The pumping rate for the constant-rate test will be assigned based on the analysis of the step-drawdown test.

Water level measurements in the test well and adjacent monitoring wells will be taken by pressure transducers and automatic data loggers. Manual measurements will also be taken periodically to verify transducer data and to supplement the database. These data will be used to analyze the response of the aquifer system to pumping and hydraulic capture of the extraction wells. Additionally, rainfall and barometric pressure will be measured prior to, and during the testing phase.

During the constant rate tests, groundwater samples will be collected from the extraction wells every 4 hours to evaluate the expected influent water quality for treatment. These data will be used to design appropriate treatment units. Each sample will be analyzed for TCL low-concentration VOCs and TAL metals. DO, pH, salinity, conductivity, turbidity and oxidation potential (Eh) will be measured in the field. Discharge water generated during the aquifer test will be filtered through a granular activated carbon (GAC) unit prior to discharge to the storm sewer. A TPDES permit will be required. Sampling procedures and analytical methods will be detailed in the QAPP.

Turpentine Run Flow Measurements

To assist the evaluation of RD discharge options, flow measurements of the stream will continue during the second field event to build on the Turpentine Run database which was begun during the first field event. Flow measurements will be taken daily at three selected measurement stations. If significant storm events occur during field activities, measurements will be taken more than once per day - before, during, and after significant rain events. USGS publications will also be referenced for baseline, historic data, and rainfall/runoff comparisons.

2.2.4 SUBTASK 2.4 Drilling and Well Installation

Monitoring Wells

Eight monitoring wells will be installed to address data gaps identified during the RI/FS. The proposed monitoring wells are listed below, and are shown on Figure 1.

RD 1: A deep well located between LaPlace and MW-22D to provide contaminant data at the center of the "southern " VOC plume. These three data points will provide a cross-sectional picture of the plume in this vicinity.

RD 2 and 3: A shallow and deep well about 1,000-1,500 feet downgradient of the existing Delagarde well, near the suspected wetland area along Route 32 in the lower Turpentine Run. These wells will provide data on the downgradient extent of contamination and water level data to assess head gradients and if groundwater is discharging to the wetlands.

RD 4: A deep well located to delineate the eastern extent of contamination of the "northern" VOC plume.

RD 5: A shallow well located downgradient of the Curriculum Center to delineate the eastern extent of contamination in its vicinity. The data presented in the RI/FS suggests there is a discrepancy between flow directions and plume migration at this location.

RD 6: A deep well to be used for measuring water levels during the aquifer test of extraction well RW-2 or RW-3 and contaminant concentrations in the aquifer.

RD 7: A deep well to be used for measuring water levels during the aquifer test of extraction well RW 1 and contaminant concentrations in the aquifer.

RD 8: Contingency well whose final location is to be decided after results of Round I groundwater sampling have been reviewed. A suitable candidate location is to the southwest of the existing Steele well.

Site access issues (topography and vegetation) may limit the final locations of these monitoring wells. During the site reconnaissance trip, the most suitable well sites will be chosen, as close as possible to the locations shown on Figure 1 in order to satisfy data objectives.

It is anticipated that the boreholes will be advanced using the air-rotary or air-hammer drilling method. Monitoring wells will be installed as 4-inch diameter wells.

Monitoring wells will be completed with Schedule 80 PVC riser casing and with 20-foot lengths of 0.020-inch slotted schedule 80 PVC screen. Screen depths will be determined in the field, but will follow the same "pattern" of installation as other monitoring wells in the Tutu valley (i.e., "shallow" wells will be installed across the water table, while "deep" wells will be installed 30 to 50 feet below the water table). The screens are recommended to be 20 feet instead of 10 feet to give a better chance of intercepting water bearing fractures. Clean gravel will be installed around the well screens to a measured depth of approximately 2 to 3 feet above the top of the screens. A two to three foot thick bentonite pellet seal will be placed above the gravel pack and a cement/bentonite slurry will be tremied in up to three feet below ground surface. Monitoring well installation procedures utilizing EPA-approved methods will be fully detailed in the QAPP.

Extraction Wells

Two of the five extraction wells called for in the ROD (RW-1 and either RW-2 or RW-3) will be installed during the field investigation. These will be hydraulically tested to provide design parameter data on:

- hydraulic capture;
- hydraulic characteristics of the aquifer in areas of extraction/recovery;
- influent water quality; and
- operating parameters of extraction system.

The anticipated locations of these extraction wells are shown in Figure 1, at the downgradient ends of the northern and southern VOC plumes. Final locations will be determined based on Round I groundwater sample results, groundwater flow modeling, site reconnaissance, and site access restrictions. If plume conditions have changed appreciably since the RI/FS, it may be necessary to modify the extraction well locations, in consultation with EPA and the USVI.

The extraction wells will be drilled using either air-rotary or air hammer methods. Each borehole will be thoroughly developed before installation is completed to ensure that water-bearing fractures are not clogged with drill cuttings and dust. Each of the two extraction well boreholes will be partially cored (up to 50 feet in each) for detailed geological descriptions using a 3-inch NQ core barrel. Cores will be placed in core boxes and labeled according to depth. The cores will be logged by a qualified geologist and described by rock type, color, stratification (if any), hardness, fracturing, secondary porosity and mineralization, etc. Following coring, each of the two holes will be reamed to a diameter of 8 inches.

Ideally, the extraction wells will be installed as open bedrock boreholes. If sloughing conditions are encountered during drilling, contingency measures to install screen, gravel pack and cement will be implemented. Open/screened depths will be determined in the field based on drilling observations (e.g. the location of water-bearing fractures) and packer testing of surrounding deep wells. Well installation procedures utilizing EPA-approved methods will be fully detailed in the QAPP.

2.2.5 SUBTASK 2.5 Environmental Sampling

The rationale and approach for collecting environmental samples is discussed in Subtasks 2.3 and 2.4. Based on the field program described above, the following environmental samples and analyses are anticipated for laboratory analysis:

Type of Sample	# Samples	Lab Analyses
Groundwater - Round 1		
Existing monitoring wells	31	TCL VOCs, BNAs, TAL Metals, conventional water quality[1], biodegradation parameters[2]
Supply wells	11	
Groundwater - Round 2		
Existing monitoring wells	10	TCL VOCs, TAL metals, conventional water quality, biodegradation parameters[2]
New monitoring wells	8	
Extraction wells	2	
Aquifer test influent sampling	24	TCL VOCs and metals
Packer test samples (6 wells)	36	TCL VOCs
Surface Water		
Wetland	3	Full TCL/TAL, conventional water quality
Sediment		
Wetland	3	Full TCL/TAL, grain size, salinity, TOC, Eh
Treatability Study (Task 6)		
Influent groundwater	36	Treatability parameters[3]

Notes:

1 Conventional water quality parameters analysis will include: TDS, TSS, nitrate/nitrite, sulfate, chloride and carbonate/bicarbonate.

2 Biodegradation parameter analysis will include: BOD, COD, hydrogen sulfide, methane/ethane/ethene, and total phosphate. Not all samples will be analyzed for biodegradation parameters. Eleven wells from Round I and six wells from Round II will be analyzed.

3 Treatability parameter analysis will include: TDS, TSS, total and dissolved iron and manganese, alkalinity, acidity, hardness, and settleable solids.

2.2.6 SUBTASK 2.6 Geotechnical Survey

Up to 15 soil borings (each to anticipated depths of less than 10 feet) will be conducted to examine depth to bedrock and soil characteristics at the selected treatment plant location and possibly along pipeline routes. No specific geotechnical testing (laboratory or otherwise) of overburden samples will be required due to the shallow depth to bedrock across the study area. Soil borings will consist of splitspoon sampling to bedrock and collecting blow count data. Sufficient information should be available from past and current proposed well drilling programs (blow counts, etc.) to complete the design of the treatment plant.

Subtask 2.6 also requires a topographic survey. CDM Federal will procure a licensed surveyor to determine locations and elevations of the new monitoring and extraction wells and to survey the surface topography, property boundaries, and any existing structures and utilities at the agreed site of the future groundwater treatment facility.

It is assumed that EPA will be able to obtain a digital copy of the site-wide topographic survey performed in November 1993 by R. Lopez de Azua & Associates during construction of the Tutu Park Shopping Center. This survey work will not be duplicated during the RD. However, facilities and structures built after 1993 will need to be added to the existing base. It may also be necessary to perform additional surveying of sewers, water lines and other utilities.

2.2.7 SUBTASK 2.7 Wetland Delineation

The wetland subtask includes wetland mapping, wetland functional analysis, water level monitoring, sediment and surface water sampling, estimates of the saltwater position in Turpentine Run, and a comparison of this information to reference wetland data. It also includes wetland delineation, flora and fauna determination, and analysis of wetland functions for two wetland areas along the lower Turpentine Run. The upper wetland area is situated in the Mt. Zion area where the leading edge of site groundwater contamination approaches Route 32 and crosses Turpentine Run Road. The lower wetland is situated in the Nadir area at the mouth of Turpentine Run at Mangrove Lagoon. Wetland delineation of both wetlands will be conducted according to established methods described in the Federal Manual Wetlands Delineation (US Army Corps of Engineers, 1989).

Flora and fauna will be determined by visual inspection of habitats and identification of flora at each of the wetland areas. Federal and State wildlife agencies will also be contacted for information on threatened and endangered species sightings and information on communities of special ecological concern. CDM Federal will perform an assessment of wetland functions for both the upper and lower wetland areas using the Wetland Evaluation Technique (WET II) model. The mapping, functional analysis, and flora and fauna determination will be performed during the first field event.

During the second field event, two monitoring wells and 10 piezometers will be installed in the Mt. Zion wetland area to evaluate the extent of contamination and monitor water levels. The exact locations of the wells and piezometers will be determined with EPA and the National Oceanic and

Atmospheric Administration (NOAA). Locations will be shown in the QAPP. Data from these locations, along with groundwater modeling results, will be used to assess whether contamination is likely to discharge to any wetland areas, and if wetland boundaries may be adversely impacted by groundwater extraction or discharge associated with the Tutu remedy. Water levels will be monitored monthly for four months and will also be monitored during the aquifer test.

To assess whether contaminated groundwater is discharging to wetland areas, eight seep/surface water and sediment samples will be collected upgradient, within, and downgradient of the delineated wetlands. All samples will be analyzed for EPA's full TCL/TAL list of analytes. Water samples will also be analyzed for conventional water quality parameters. Sediment sample analysis will also include grain size, salinity, TOC and Eh.

The monitoring data will be compared to a local reference wetland. The local reference wetland will be selected in consultation with EPA, NOAA and DPNR for comparison with the wetlands assessment of the Mt. Zion area.

CDM Federal will also perform a qualitative assessment using the groundwater model to estimate whether a change in position of the saltwater interface in the mangroves at the mouth of Turpentine Run could occur as a result of the groundwater remediation system. The availability of pumping data from the cement factory is vital to the success of this activity.

2.2.8 SUBTASK 2.8 Disposal of Field-Generated Waste

Investigation-derived wastes (IDW) from the drilling, the environmental sampling events, and the aquifer pumping test, will be disposed of by a waste removal/disposal firm under subcontract to CDM Federal, in accordance with all applicable Territory and Federal requirements, including RCRA and Toxic Substance Control Act (TSCA) regulations.

Wastes generated during the RD, including drill cuttings, development water, purge water and personal protective equipment (PPE) will be placed in Department of Transportation (DOT)-approved 55-gallon drums or tanks and stored on the Site for future testing and disposal. Drums will be labeled and stored on wooden pallets and covered with waterproof tarps.

CDM Federal will prepare a detailed scope of work as part of the process to procure a waste removal subcontractor.

2.2.9 SUBTASK 2.9 Subcontractor Procurement

This subtask will include the procurement and management of all subcontractors to complete the field investigation activities. To support the proposed field activities, the following subcontractors will be required:

- a USVI-licensed driller to install groundwater monitoring wells, extraction wells, piezometers, geotechnical borings, conduct packer tests and aquifer tests;
- a USVI licensed surveyor to survey the site of the proposed groundwater treatment facility and the locations and elevations of all new monitoring well locations;
- a laboratory to perform the geotechnical analyses and to analyze specific water quality parameters not available through the EPA Contract Laboratory Program (CLP);
- a waste removal and disposal contractor; and
- a Cultural Resources Specialist.

All subcontractor procurement packages will be subject to a quality assurance and technical review.

2.3 TASK 3 - GROUNDWATER MODELING

A groundwater flow model of the Turpentine Run area will be developed to assist in making decisions related to the design of the Site-Wide Groundwater Extraction and Treatment System (System). The objectives of groundwater modeling are to:

- Project the change in the dimensions of the target plume area, from the observed 1994 position (based on field data) to the estimated 1999 position when the System is expected to go online. This update will be used to assist in locating additional monitoring wells during the predesign investigation. The design will be based on the predesign data, and model extrapolations of concentrations between those observed in monitoring wells.
- Assess the interactions between water supply wells still operating in the aquifer and the Turpentine Run planned System.
- Simulate the flow of groundwater and the transport of conservative "tracer" contaminants (i.e., particle clouds) under various extraction/discharge scenarios. Determine the most practical extraction system in terms of capture.
- Estimate the hydrologic impacts to wetland areas as a result of the various scenarios.
- Assess whether the various scenarios have the potential to cause significant and rapid advances of saltwater intrusion in the Turpentine Run aquifer.

- Assist in determining which existing monitoring wells are suitable for operational monitoring of the System, and identify the need and location for any additional operation monitoring wells.

- Estimate whether the various groundwater remediation scenarios will reduce or eliminate the yield of water supply wells in the lower Turpentine Run basin.

- Estimate the recharge and discharge areas for the Turpentine Run aquifer (i.e., where does groundwater discharge along Turpentine Run?)

The modeling will be done in phases so that the continuous data from field investigations and modeling can be used synergistically. As a result, decisions during the predesign and design process can be based on the most current understanding of site and aquifer conditions.

CDM Federal will use the state-of-the-art 3-dimensional groundwater flow model developed by Camp Dresser & McKee (CDM), DYNamic groundwater FLOW (DYNFLOW) model to simulate both confined and unconfined groundwater flow conditions. DYNFLOW can be used to simulate both steady-state (equilibrium) and time-varying (transient) aquifer conditions. It uses a finite element solution technique to solve a set of groundwater flow equations based on Darcy's Law and the principle of conservation of mass. DYNFLOW uses elements that are triangular in plan view because they provide flexibility in representing features of the aquifer system, such as boundary conditions, stratigraphy or streambeds.

DYNFLOW has been reviewed and tested by the International Groundwater Modeling Center (IGWMC). This validation entailed verifications of the computer code and modeling theory, testing of the versatility of DYNFLOW's applications, and scrutinizing the model documentation. DYNFLOW was determined to be a logical and efficient computer code capable of modeling a variety of stratigraphic and hydrologic scenarios.

The model has been used successfully to represent groundwater flow at numerous Superfund sites and other sites, including the Ciba-Geigy (New Jersey) site; the Port Washington Landfill (New York) site; Waldick Aerospace (New Jersey) Site; and the Ewa Caprock aquifer (Hawaii).

The Turpentine Run aquifer is a highly fractured, anisotropic system. The aim of the groundwater modeling task will be to represent basin-wide groundwater flow by simulating the fractured aquifer as an equivalent porous continuum, rather than simulating flow through individual fractures (not enough information is feasibly obtainable). The applicability of the equivalent porous media approach is suitable for the scale of the sub-regional model proposed for the Tutu aquifer. The proposed approach will simulate fracture zones, not individual fractures.

2.3.1 SUBTASK 3.1 - Model Development/Calibration

The first phase of the modeling will refine the conceptual hydrogeologic model of the site area, develop a groundwater flow computational model capable of representing the groundwater flow at, and downgradient of the Tutu Wells site and calibrate the model to observed conditions in Turpentine Run. The horizontal and vertical extent of the Tutu model will extend beyond the limits of the Tutu Wells Site to include all of the groundwater system that affects, or is affected by, flow within the Tutu area. To that end, the horizontal limits of the model will be extended to natural hydrogeologic boundaries, such as streams or groundwater divides (as depicted by USGS maps of the various aquifers). The boundaries of the Turpentine Run catchment area will be used as the horizontal model boundaries. At this time, it is estimated that the base of the model will be located at sufficient depth to ensure that modeling results will not be impacted by imposed boundary condition. Initially, the model base boundary will be assumed to be a no-flow boundary. If this assumption produces unsatisfactory results, then a fixed head boundary condition will be assumed.

Before developing the computational groundwater flow model, a workshop will be held with CDM experts, EPA, and other stakeholders identified by EPA, to obtain input, develop a consensus on the conceptual hydrogeologic model, and identify the critical issues for the analysis.

To develop the groundwater flow model, all of the factors controlling groundwater flow will be identified and quantified. These factors, along with the information sources that will be used to describe them, are summarized below.

Mapping Data - will be based on the existing digital aerial survey (G&M) of the Tutu Wells Site, combined with purchased USGS digital maps of the Turpentine Run Basin.

Geologic Data - will be based on the regional stratigraphic information summarized in USGS reports (Jordan & Cosner, 1973; Donnelly, 1966; as well as site-specific reports by Geraghty & Miller, 1995; Forensic Environmental, 1997; and Erler & Kalinowski, 1995) and original boring logs from the site. As stratigraphic information becomes available from the predesign field work, the model stratigraphy will be updated and refined.

Hydrogeologic Properties - will be based on ranges of regional hydraulic properties available in the literature, and the observations from site aquifer tests. Modeled properties will be adjusted within these documented ranges (adjustments will be based in part upon interpretation from well logs) to match observed water levels/piezometric heads and hydraulic gradients.

Boundary Conditions - will be based primarily on information in the USGS reports for water levels/piezometric heads along the model perimeter. The horizontal boundaries, with the exception of the Mangrove Lagoon discharge area, will be no flow boundaries representing groundwater divides. The boundaries for the bottom of the model and the Mangrove Lagoon boundary will either be no-flow or fixed head boundaries, based on the USGS reported head levels. Sensitivity runs will be conducted to assess the model sensitivity to these fixed boundary conditions.

Data from USGS reports suggest that the lateral extent of the Tutu aquifer can be approximated by the surface catchment area. With lack of water level data in outlying areas of the catchment area, this assumption is reasonable as a starting point. Groundwater tables are often subdued expressions of topography. If additional data or modeling simulations suggest otherwise, boundaries can be modified in consultation with DPNR and EPA. The base of the model will be set at some arbitrary depth, sufficiently deep so that the lower boundary does not impact the simulations. The lower boundary could be the approximated fresh water/saltwater interface (at a depth of about 4,000 ft) or it could be shallower.

Fluxes - Water supply pumping, recharge from rainfall and stormwater runoff and other manmade discharges (e.g. wastewater discharges to Mangrove Lagoon) will be the fluxes quantified and specified in the model. Recharge or discharge fluxes to streams and wetlands will be computed. Model predicted stream flows will be compared with measured data as an additional calibration check.

Water supply pumping. Water supply pumping at each well (in excess of 5 gpm capacity) in Turpentine Run from 1994 through 1997 will be based on historical pumping records, permitted pumping rates, USGS records of typical pumping rates and well capacity, and knowledge of which wells were in operation during that period. This pumping will be assigned to appropriate model levels to represent the approximate depth of the pumping well.

Recharge. A reasonable range of recharge from rainfall will be estimated based on monthly rainfall records from WAPA and various recharge estimating techniques presented in USGS publications. The recharge will be varied within the range to yield the best match with observed water levels. Areas served by a sewage collection system will be assumed to receive no recharge from wastewater discharges. Areas served by onsite septic systems will be assumed to recharge its wastewater on site. An estimate will also be developed to account for leakage from WAPA pipes.

The flow model will be calibrated to steady-state conditions observed during two time intervals. Those time periods will be selected based on spatial coverage of data, availability of data, and the antecedent rainfall conditions. In addition, one transient calibration will be performed against one of the aquifer pump tests. During the process of calibration of the model, each simulation will be compared to site-specific data to ascertain the success of the previous calibration efforts and to identify potentially beneficial directions for further calibration efforts. Procedures described in ASTM Standard Guide D 5490-93 will be used for making comparisons between groundwater flow model simulations and measured field data. Measures of success will include the water budget, groundwater flowpaths, vertical gradients, ability to simulate varying hydrologic conditions, and uniqueness of the modeling solution.

Sensitivity runs varying the major assumptions incorporated into the model (e.g. estimates of hydraulic conductivity, recharge, etc) will also be conducted to test the model's response to changes in various parameters and determine those parameters which control the hydraulic response of the aquifer system.

An internal peer review workshop will be held to review and assess the model's calibration for the purpose of this project. EPA and other stakeholders will be invited to this technical work session. The stakeholders will be encouraged to test their hypotheses on groundwater movement and to fully understand any model uncertainties. The goal of these workshops is to increase the understanding of the stakeholders early in the process and to communicate the various uncertainties, allowing better decisions and planning.

2.3.2 SUBTASK 3.2 - Model Application

This subtask will include the application of the model to perform various assessments. This task will start with developing a baseline groundwater flowfield which will be used to project into the future, under a no remediation scenario. The various remediation scenarios will then be added to this baseline flowfield scenario.

Updated Estimate of the extent of contamination. The contamination plume as mapped by G&M in 1995 will be moved forward in time under "average conditions", to determine the likely extent of the target area at the projected time that the System goes online. This estimated position will be confirmed with sampling of existing and new monitoring wells during the predesign phase of the RD.

Evaluate FS System Concept. Evaluate the effectiveness of the proposed System as conceptualized in the FS (1995). Determine whether pumping rates and extraction well locations are sufficient to provide plume capture. Capture Zone Analysis will be based on estimated 3-D flow and simulated conservative particle clouds to represent the known contamination. Determine the effects of the FS system on water levels in nearby wetland areas, the potential for significant upconing of deep, saline formation water, and any impacts to water supply wells still operating in Turpentine Run. If field data and preliminary modeling indicate that significant upconing of saline formation water is likely to occur, then more detailed modeling (e.g., of a two-phase system) may be required. This, however, is beyond the scope of this work assignment.

There are two aspects to the issues of salt water intrusion/upconing. In the lower reaches of Turpentine Run, added remedial pumping could induce migration of sea water. In upper Turpentine Run, within the study area, the salt water upconing discussed in the work plan is deep connate formation water moving slowly through the fracture system. St. Thomas is a volcanic island that rose out of the sea. Ancient sea water may be present in the fractured bedrock at depths shallower than predicted by the Ghyben-Herzberg principle.

Test Alternative System Concepts. Simulate up to 5 alternative scenarios in an effort to improve capture, reduce flow rates, reduce operational period and reduce any secondary impacts to wetlands, downstream supply wells, and the potential of intrusion/upconing of deep, saline formation water.

Simulate Preferred Scenario to locate operational monitoring wells that may be needed. An evaluation of the time required for contamination at levels less than 100 ppb total VOCs not captured by the active remediation to reach MCLs will also be conducted (including a sensitivity analysis).

2.3.3 SUBTASK 3.3 - Prepare Draft Report

The groundwater flow model development and calibration will be summarized, along with the results of the sensitivity analyses, and model applications in a Technical Memorandum. CDM Federal will respond in writing to all EPA and stakeholder comments, and revise the document accordingly. It is assumed that EPA will consolidate comments from all reviewers for written responses.

2.3.4 SUBTASK 3.4 - Final Report

CDM will revise the draft modeling Technical Memorandum to address all significant comments. CDM Federal will append the final report to the Basis of Design Report.

2.4 TASK 4 - SAMPLE ANALYSIS / DATA VALIDATION

Several different types of analytical work will be required for the predesign investigation:

- Analysis of groundwater to delineate the current plume boundaries and concentrations (low-concentration VOCs, BNAs, metals, conventional water quality parameters, and biodegradation parameters);
- Analysis of influent concentration during the aquifer test (VOCs and metals);
- Analysis of conventional water quality parameters to determine treatment system requirements (TSS, TDS, chloride, nitrate/nitrite, sulfate, etc.);
- Bench-scale treatability testing of metals to determine appropriate methods for their removal. This testing will be performed by a vendor contracted by CDM Federal;
- RCRA waste characterization analysis to determine disposal requirements for investigation derived waste (TCLP, ignitability, corrosivity, reactivity). Note that these analyses will be performed by the waste disposal subcontractor.

CDM Federal will utilize EPA's CLP program for sample analysis of TCL organics and TAL metals. A subcontractor laboratory will be solicited to analyze conventional water quality parameters and biodegradation parameters.

2.4.1 SUBTASK 4.1 - Sample Management

The CDM Federal Analytical Services Coordinator will be responsible for all CLP and non-CLP laboratory bookings and coordination with the Regional Sample Control Center (RSCC) for sample tracking prior to and after sampling events. Sample management activities will include:

- Preparation of sample projections;
- Request for analytical services in accordance with procedures outlined in the Users Guide to the Contract Laboratory Program, December, 1986;
- Coordination with the EPA Contract Laboratory Analytical Support Services (CLASS);
- Sample tracking.

For all Routine Analytical Services (RAS) activities, CDM Federal will notify CLASS to enable them to track the shipment of samples from the field to the laboratories and to ensure timely laboratory receipt of samples. Sampling Trip Reports will be sent directly to the RSCC, CLASS, and the EPA RPM within ten working days of final sample shipment, with a copy sent to the CDM Federal Analytical Services Coordinator.

2.4.2 SUBTASK 4.2 - Data Validation

This task provides for data validation (the process by which the quality of the data and chain of custody are verified) and review of usability of the data. Only the wetland characterization samples (surface water and sediment) and those groundwater samples that used to delineate the current boundary of the groundwater plume will be validated. Samples to be used for design parameters do not require data validation. Samples analyzed by the EPA CLP will be validated by EPA; therefore, CDM Federal does not plan to perform any data validation activities.

The EPA-validated data results will be presented to EPA as an Appendix to the Predesign Report. The samples to be collected and the parameters to be analyzed for each sample are described in this Work Plan. The number of samples, analytical test methods, levels of detection, holding times, parameters, field sample preservation and QC sample protocols will be listed in the QAPP.

2.5 TASK 5 - DATA EVALUATION

This task includes work efforts related to the compilation and interpretation of all predesign analytical and field data. The data will be entered into a computer database and will be utilized in the preparation of the Predesign report tables, maps and figures.

2.5.1 SUBTASK 5.1 - Data Evaluation of Predesign Field Results

The CDM Federal hydrogeologist, groundwater modelers and design engineers will evaluate the data obtained during the predesign investigations to determine the ultimate design parameters for the

groundwater extraction wells and the water treatment system. As part of this effort, CDM Federal will compile the existing and new field data (e.g. soil boring logs, geophysical logs, well drawdown curves, hydrogeologic profiles, etc.). CDM Federal will use the existing database developed during the RI and FS. Any historical data that DPNR possesses that is not presented in the RI or FS can be added to the database by CDM Federal, if DPNR provides the data to EPA in a summarized format.

The data to be evaluated in this task include:

- Soil boring and monitoring well logs,
- Field sampling data,
- Hydrogeological testing data,
- Geophysical data,
- Geotechnical data, and
- Analytical results.

CDM Federal will use an appropriate database program and standard industry spreadsheet software programs for managing all data related to the sampling program. The system will provide data storage, retrieval, and analysis capabilities, and be able to interface with a variety of spreadsheet, word processing, statistical, and graphics software packages. New and existing data will be organized, formatted, and input into the database for data evaluation. Data tables comparing the results of the various phases of sampling efforts will be prepared and evaluated. Analytical data results will interface with graphics packages to illustrate contaminants detected, extraction well capture zones, etc.

2.5.2 SUBTASK 5.2 - Data Mapping

The predesign data will be posted on site basemaps for the various predesign reports. Figures will be generated in plan view and cross section to show the extent of groundwater contamination. The extent of contamination will be mapped to the appropriate MCL for the contaminant. Graphic illustrations in the Predesign Report will include geological profiles, cross sections, contaminant isoconcentration maps, and longitudinal and cross sectional profiles of groundwater contamination and capture zones.

2.6 TASK 6 - TREATABILITY STUDIES

This task involves bench-scale and/or pilot testing of the control of metals in the proposed groundwater treatment system. Although the groundwater treatment system's primary purpose will be to treat organic groundwater contamination, past sampling data have indicated that naturally occurring metals are elevated in the aquifer and must be considered in the design of the treatment system. Parameters of potential concern include TDS, manganese, iron, and chloride. Pretreatment of these metal oxides and salts may be required to prevent or control their potential impact on the performance and maintenance of the treatment facility(s).

CDM Federal will conduct a treatability study to determine whether the remediation technology or vendor of the technology can achieve the performance standards. The testing will be used to provide optimum sizing and operations criteria for the design drawings and specifications and in the engineer's cost estimate.

2.6.1 SUBTASK 6.1 - Bench-Scale Testing

Bench-scale testing will be performed to determine whether pretreatment is required, what the preferred treatment technology is, and to develop design criteria for the treatment system. The processes to be tested on the bench include: precipitation, green sand filtration, and aeration.

CDM will perform the following activities for the bench-scale treatability testing:

- Prepare a Treatability Study Work Plan,
- Provide test facility and equipment,
- Test and operate equipment,
- Retrieve samples for testing,
- Prepare a Technical Memorandum, and
- Characterize and dispose of test residuals.

The Treatability Study Work Plan will describe the technologies to be tested, test objectives, test equipment or systems, experimental procedures, treatability conditions to be tested, measurements of performance, analytical methods, data quality objectives, data management and analysis, health and safety procedures, and residual waste management.

Three types of bench-scale testing will be performed in the field: jar tests, green sand filtration tests, and aeration tests. These tests will determine chemical oxidation and precipitation rates and flocculation characteristics of the influent groundwater. Precipitation testing will be performed using conventional jar test methods. Green sand filtration will be tested using small-scale column tests. Aeration will be tested in small scale tank tests. Because of the quantity of the water required to perform these tests, and the sensitivity of the test results to any changes in water characteristics during shipping, this testing will be performed at the site in the field trailer complex. For the aeration testing, CDM Federal will set up a small tank system (e.g. 50 gallon) with a low air-to-water ratio aeration system (e.g., 2:1) and measure the reduction of metal oxides in the effluent sludge in the tank.

The influent water for the bench-scale tests will come from the aquifer tests at the site. For planning purposes, it is estimated that up to 36 groundwater samples will be sent for laboratory analysis of parameters such as total and dissolved iron and manganese, TSS, TDS, alkalinity, acidity, hardness, and settleable solids. Screening analysis for iron and manganese will also be performed in the field using HACH analysis kits, with laboratory verification of 20% of the water quality samples. All sludge samples will be sent to the laboratory for analysis.

Following performance of the bench-scale testing, CDM Federal will prepare a technical memorandum for EPA reporting the results of the testing and recommending appropriate parameters for metals treatment to be used in the design. The technical memorandum will recommend whether or not pilot-scale testing should be performed.

All residual materials generated during the bench-scale treatability testing will be contained, characterized and disposed in accordance with local, State, and Federal regulations.

2.6.2 SUBTASK 6.2 - Pilot-Scale Testing (Contingency)

At present, CDM Federal does not anticipate that it will be necessary to perform pilot-scale testing for the design of the groundwater treatment system. If this subtask is required it will involve the same steps as Subtask 6.1.

2.7 TASK 7 - DISCHARGE OPTIONS ANALYSIS, FACILITIES SITING AND DETERMINATION OF PERMITTING REQUIREMENTS

This task includes work efforts related to the ultimate discharge and /or water reuse options for treated effluent and siting of the future groundwater treatment plant(s). CDM Federal will conduct an evaluation to determine a recommended option for discharge. This issue can impact the level of treatment required by the groundwater treatment system, permitting of the planned system and monitoring.

DISCHARGE OPTIONS ANALYSIS

CDM Federal will meet with EPA and the USVI agencies involved (e.g., DPNR, WAPA) to determine viable discharge and reuse options to be included in the evaluation. It is anticipated that a minimum of two meetings will be required: a preliminary meeting to initiate the task and a second meeting to discuss the evaluation presented in the draft report generated after the analysis is complete.

The treated effluent discharge/reuse evaluation will include:

Discharge to Surface Water Option:

1. Determine the impact on the consumptive sustainable yield for the aquifer system (in particular impacts on other water supply systems) and potential migration of saline formation water into the potable aquifer system.

2. Determine present worth cost of groundwater remediation with this discharge option. Costs should include level of treatment, monitoring and cost for maintaining existing water supply to the area (rain cistern and trucking of water).

3. Determine whether maintaining the existing water supply to the area has negative impacts on other water supply wellfields on the island (i.e. evaluating increased demand on other water supply fields that exceed their safe yield).

4. Assessment of potential environmental impacts to wetlands in the open channel where the discharge occurs.

Potable Reuse Options:

Since issuance of the ROD, the USVI has indicated that they will not accept the distribution of treated groundwater from the site for potable use. Therefore, this option will not be evaluated.

Non-Potable Reuse Options:

CDM will evaluate options to protect the sustainable yield of the aquifer by reducing the stress caused by groundwater withdrawal for the remedy:

1. Determine present worth cost of remediation using this discharge option.

2. Consider reinjection or recharge of a portion of the treated water to the aquifer.

3. Consider distribution of treated water to industrial water consumers or hotels to reduce their groundwater withdrawal needs.

FACILITIES SITING

For this evaluation, CDM Federal, in consultation with EPA and the USVI, will:

- Determine possible locations for groundwater treatment plant(s) and treated water distribution system.

- Evaluate locations with EPA, USVI DPNR, WAPA, property owners and Responsible Parties so that EPA can select final location and obtain site access.

DETERMINATION OF PERMITTING REQUIREMENTS

CDM Federal will:

- Determine all USVI permits that will be required for the treatment system and selected discharge option.

- Obtain permit requirements so that system can be designed to meet permit specifications.

2.7.1 SUBTASK 7.1 - Draft Discharge Options and Facilities Siting Report

CDM Federal will present the analysis of the discharge/reuse options and facilities siting in a draft report to EPA. The evaluation will consider:

- The reliability of the treatment technology to meet MCLs or other discharge criteria.
- Additional treatment requirements for naturally occurring inorganic constituents and/or the possibility of obtaining a waiver from standards for parameters affecting the aesthetic characteristics of the treated water.
- Potential discharge/reuse options that will reduce net withdrawal of groundwater from the aquifer in order to protect its safe yield.
- Monitoring requirements for the treatment/discharge options.
- Legal and constructability constraints.
- Present worth costs for each discharge/reuse option evaluated.

2.7.2 SUBTASK 7.2 - Final Discharge Options and Facilities Siting Report

Upon receipt of EPA/USVI comments on the draft report, CDM Federal will prepare a Final Discharge/Reuse Options and Facilities Siting Report.

2.8 TASK 8 - PREDESIGN REPORT

2.8.1 SUBTASK 8.1 - Draft Predesign Report

The results of the predesign investigations will be compiled and interpreted in a Predesign Report. The report will provide the site-specific design parameters needed to begin the design phase of this assignment.

2.8.2 SUBTASK 8.2 - Final Predesign Report

Following receipt of comments from EPA and other stakeholders on the Draft Predesign Report, CDM Federal will revise the document and submit a Final Predesign Report.

2.9 TASK 9 - REMEDIAL DESIGN

CDM Federal will conduct the design of the groundwater extraction/treatment system as outlined in the ROD. This design will include:

i. Provision for the extraction of contaminated groundwater.

ii. A final determination of the treatment process for groundwater. The conceptual treatment process outlined in the ROD includes aeration, clarification/filtration, and air stripping.

iii. A determination of the exact number, depth, pumping rates, and location of extraction wells.

iv. A determination of the discharge/reuse option for treated groundwater.

v. A determination of commercial and/or residential wells that must be decommissioned.

vi. Determination of air monitoring requirements during construction activities at the Site to ensure that air emissions resulting from construction activities meet applicable or relevant and appropriate air emission requirements.

vii. Provisions for performing long-term surface water and groundwater quality monitoring to evaluate the effectiveness of the remedial action.

viii. Preparation of a plan for establishing institutional controls (i.e., deed restrictions and/or other similar land use restrictions)

The Remedial Design will include the preparation of a Preliminary (30% completion) Design, a Pre-Final (95% completion) Design, and a Final (100% completion) Design. The Preliminary Design will include a Basis of Design Report, drawings, and specifications. The Pre-Final and Final Designs will include drawings and specifications. CDM Federal will also prepare an Engineers Construction Cost Estimate. A Draft Operation and Maintenance (O&M) Manual will be prepared by the remedial action contractor, utilizing the performance based design.

2.9.1 SUBTASK 9.1 - Preliminary (30% Completion) Design

The Preliminary Design will include the Basis of Design Report and the plans and specifications that have been developed at that point in time. The Basis of Design Report will provide the rationale for the plans and specifications, including supporting calculations and documentation of how these plans and specifications will meet the requirements of the ROD. The Preliminary Design will include the following items (to the extent that work has been performed regarding the items), as appropriate:

1. A discussion of the manner in which the Remedial Action will achieve the performance standards;

2. A plan for establishing institutional controls (i.e., deed restrictions and/or other similar land use restrictions);

3. Preliminary drawings and process diagrams showing general arrangement of all work proposed;

5. Engineering plans representing an accurate identification of existing Site conditions and an illustration of the work proposed. Typical items to be provided (in full or partially) on such drawings include, at a minimum, the following:

6. Title sheet including at least the title of the project, a key map, the name of the designer, date prepared, sheet index, and EPA project identification;

7. All property data including owners of record for all properties within 200 feet of the Site;

8. A Site survey including the distance and bearing of all property lines that identify and define the project Site;

9. All easements, rights-of-way, and reservations;

10. All buildings, structures, wells, facilities, and equipment (existing and proposed) if any;

11. A topographic survey will be presented in intervals that clearly depict the Site topography, including existing and proposed contours and spot elevations for all areas that will be affected by the remedial activities, based on U.S. Coast and Geodetic Survey data;

12. All utilities, existing and proposed;

13. Location and identification of all significant natural features including, *inter alia*, wooded areas, water courses, wetlands, flood hazard areas, and depressions;

14. Flood hazard data and delineation, if applicable;

15. North arrow, scale, sheet numbers and the person responsible for preparing each sheet;

16. Decontamination areas, staging areas, borrow areas and stockpiling areas;

17. Survey work that is appropriately marked, recorded and interpreted for mapping, property easements and design completion;

18. Drawings of all proposed equipment, improvements, details and all other items to be developed in accordance with the current standards and guidelines of the U.S. V.I. Territory Board of Professional Engineers and Land Surveyors. Drawings shall be of standard size, approximately 24" x 36". A list of drawing sheet titles will be provided;

19. Engineering plans that will indicate the following:

    Site security measures;
    Roadways;
    Electrical, mechanical, structural, and HVAC drawings, if required.

20. Any value engineering proposals.

2.9.2 SUBTASK 9.2 - Pre-Final (95% Completion) Design

The Pre-Final Design will include, as appropriate:

i. Pre-Final plans and specifications, including draft piping and instrumentation diagrams, showing all equipment and control systems;

ii. A Draft Construction Quality Assurance Project Plan (CQAPP) for sampling, analysis, testing, and monitoring to be performed during the Remedial Construction phase of the Work. Quality assurance items to be addressed shall include the following:

- Inspection and certification of the work;
- Measurement and daily logging;
- Field performance and testing;
- As-built drawings and logs;
- Testing of the work to establish whether the design specifications are attained; and
- Testing methods appropriate to Remedial Construction include testing of Remedial Construction materials prior to use, and testing of constructed remedial components to determine if they meet design specifications.

iii. An engineer's construction cost estimate, which may be provided under separate cover concurrent with submittal of the Final Design.

2.9.3 SUBTASK 9.3 - Final (100% Completion) Design

Comments on the Pre-Final Design will be addressed in the Final Design, after EPA's review and approval.

2.10 TASK 10 - NEGOTIATIONS SUPPORT

This task includes all efforts to support Remedial Action negotiations with the potentially responsible parties (PRPs). For planning purposes, EPA has directed CDM Federal to assume the following support will be provided:

- Attend three negotiation sessions with EPA in the USVI;
- Review up to 12 technical documents from the Potentially Responsible Parties
- Prepare up to 13 Technical Memoranda concerning PRPs' activities; and
- Provide other technical assistance to EPA as requested.

2.11 TASK 11 - COMMUNITY RELATIONS SUPPORT

This task includes work efforts to implement a community relations program for the implementation of the RD at the Site. Implementation of community relations activities will enable EPA, the Territory and others contributing to remedial response efforts to continue to inform the public of planned and ongoing actions and focus and resolve controversy. Furthermore, implementation of community relations must be integrated with all technical response activities. The following activities are to be conducted as part of the community relations support for the Site:

2.11.1 SUBTASK 11.1- Revise the Existing Community Relations Plan

CDM Federal will revise the Community Relations Plan from work assignment 073-2P1D as appropriate, to indicate the current status of the Site, the upcoming remedial design, and EPA's plans to keep the community informed about the process.

2.11.2 SUBTASK 11.2 - Public Availability Meetings Support

CDM Federal will provide community relations support to EPA for two Public Availability Meetings to update the community of the status of the RD and to answer community questions. Activities that will be performed under this task include:

- Preparation, print and distribution of flyers, posters and public notice announcing EPA's meetings in the Tutu area;
- Coordination of the meeting place logistics, preparing slides, exhibits, and other audio-visual materials;

- Maintenance of the mailing lists; and
- Maintenance of the offsite repository.

2.11.3 SUBTASK TASK 11.3 - Fact Sheets

CDM Federal will prepare and distribute three (2-page) fact sheets during the RD process to provide the local residents with information about the site. Topics for the fact sheets include, but are not limited to: summary information on the site history, the status of the RD, and the schedule of predesign field work.

2.12 TASK 12 - CULTURAL RESOURCES SURVEY

CDM Federal will prepare a detailed scope of work as part of the process to procure a cultural resources specialty subcontractor. This task will include the procurement and management of the subcontractor for the cultural resources survey of the Tutu site. The subcontractor procurement package will be subject to a quality assurance and technical review.

This task includes review of the subcontractor's draft and final cultural resources survey report.

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3.0 PROJECT ORGANIZATION

The CDM Federal project team for this work assignment consists of the following key staff:

ARCS Program Manager
Robert D. Goltz, P.E.

Work Assignment Manager
Drew Bennett

Lead Design Engineer
Demetrios Klerides, P.E.

Predesign Leader
Drew Bennett

Project Hydrogeologist
Henning Moe

Field Operations Leader
Michael Valentino

Project Wetland Specialist
Nancy Zygmont

Regional Quality Assurance Coordinator
Susan Flakus

Analtyical Services Coordinator
Scott Kirchner

4.0 PROJECT SCHEDULE

The project schedule for the RD is shown in Figure 3. The schedule for this project is based on assumptions for durations and conditions of key events occurring on the critical and non-critical path. These assumptions are as follows:

- Field activities will not be significantly delayed due to adverse weather conditions.
- The schedule for the field activities is dependent on access to offsite properties being obtained without difficulty.
- The schedule is dependent on timely review and approval of the Work Plan, Quality Assurance Project Plan, and other project design documents by EPA and the USVI.

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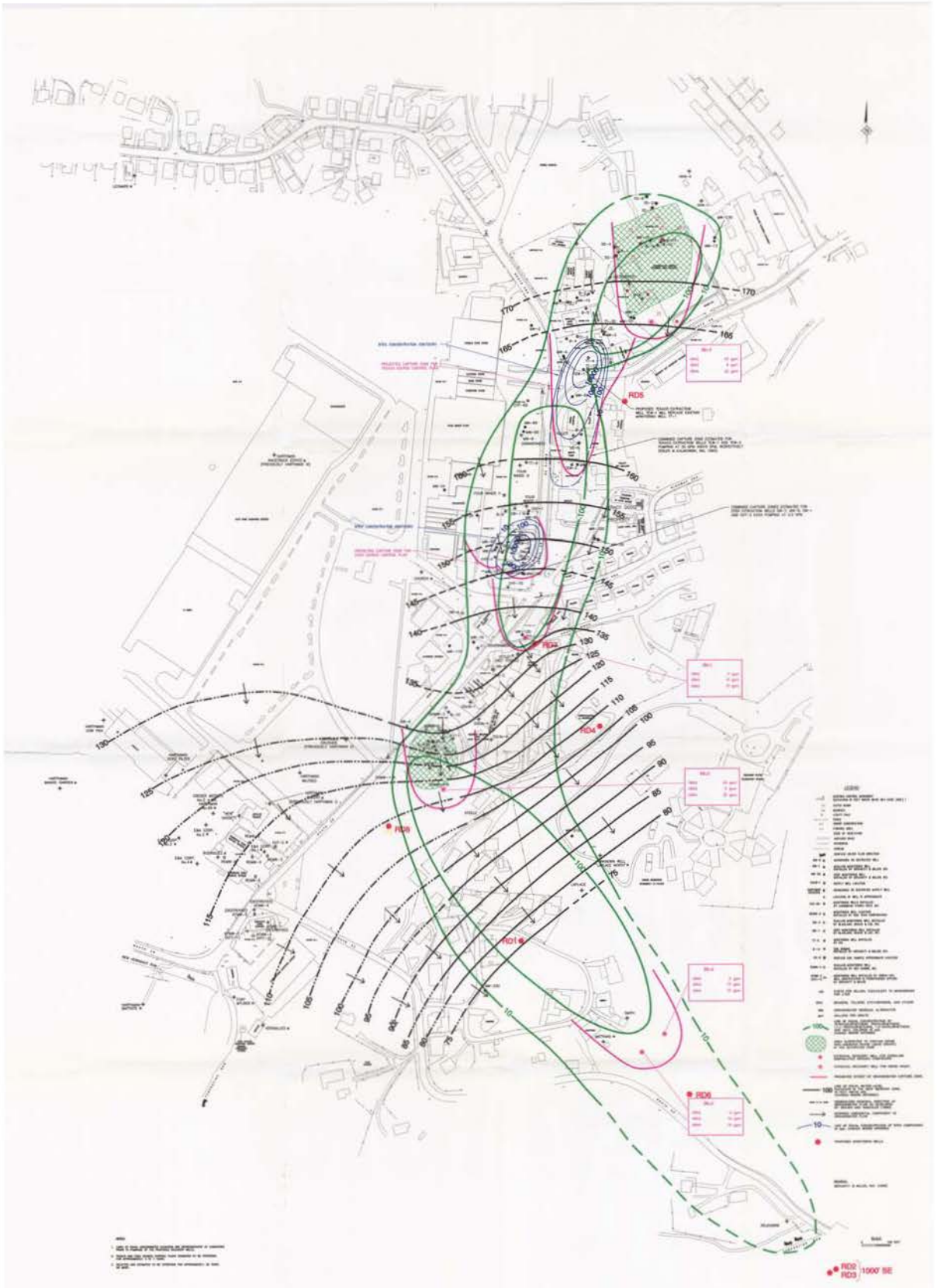
Table 1
Project Deliverables and Due Dates

Design for
Sitewide Groundwater Remediation

TASK	DELIVERABLE	DUE DATE*
1.1	Draft RD Work Plan	30 days after scoping meeting
1.1	Final RD Work Plan	15 days after receipt of EPA comments
1.3	Draft Quality Assurance Project Plan (QAPP, SMP, HSP)	30 days after approval of RD work plan
1.3	Final Quality Assurance Project Plan	15 days after receipt of EPA comments
3.3	Draft Modeling Report	15 days after completion of modeling
3.4	Final Modeling Report	With Draft Predesign Report
6.1	Treatability Study Work Plan	45 days after RD work plan approved
6.1	Final Treatability Study Work Plan	15 days after receipt of EPA comments
6.1	Treatability Study Evaluation Report	30 days after completion of Treatability Study
6.1	Final Treatability Study Evaluation Report	With Draft Predesign Report
7.1	Draft Discharge Options Analysis Report	21 days after meeting with EPA/USVI
7.2	Final Discharge Options Analysis Report	With Draft Predesign Report
8.1	Draft Predesign Report	45 days after receipt of all sampling data
8.2	Final Predesign Report	15 days after receipt of EPA comments
9.1	Basis of Design Report and Preliminary (30%) Plans and Specifications	60 days after Predesign Report approved
9.2	Pre-final (95%) Plans and Specifications	60 days after Preliminary (30%) Design approved

9.3	Final (100%) Design	21 days after Pre-final (95%)comments received
11.1	Draft Revised Community Relations Plan	30 days after approval of RD work Plan
11.1	Final Revised CRP	15 days after receipt of EPA comments

* Contingent on receipt of EPA authorization to initiate task.



CDM Federal Programs Corporation
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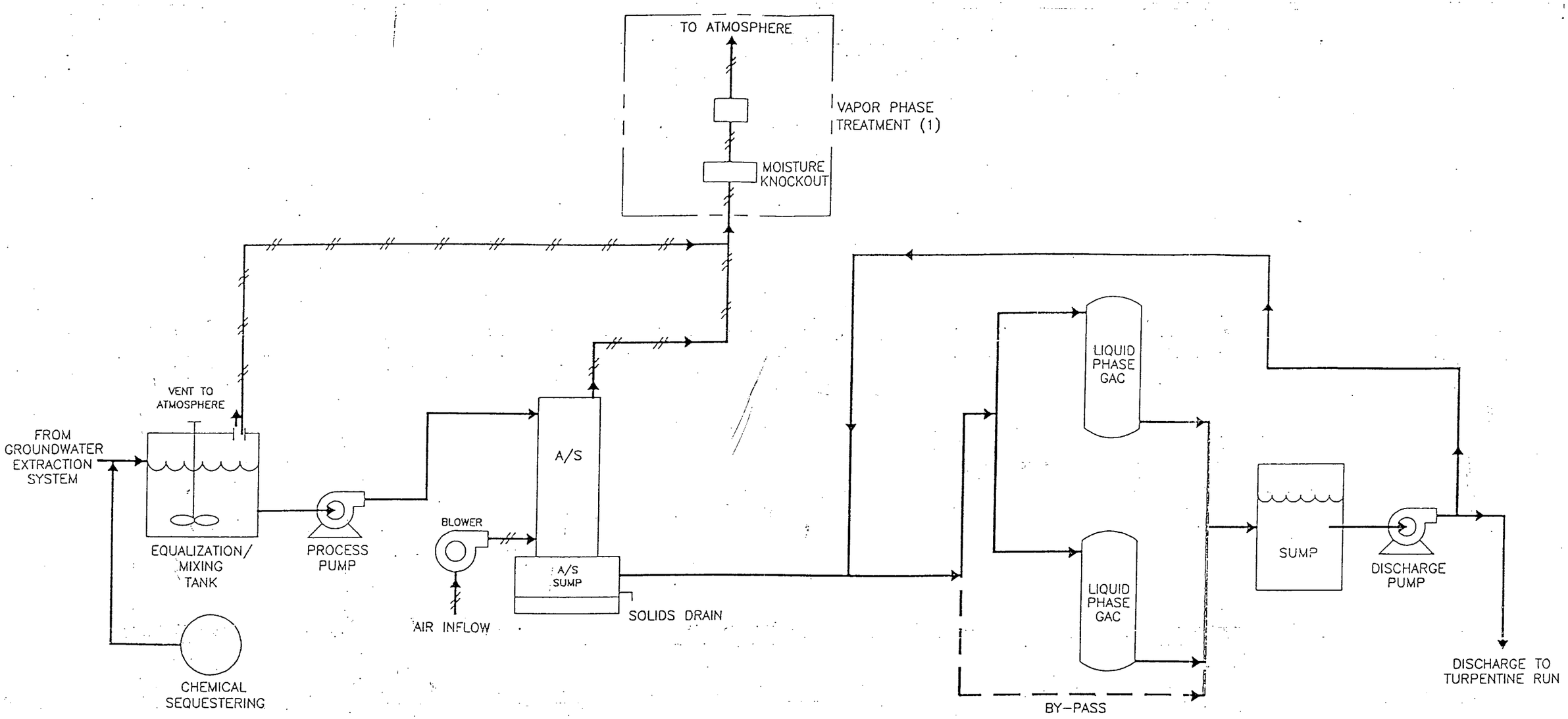

LEGEND

GAC	GRANULAR ACTIVATED CARBON UNIT
A/S	AIR STRIPPER
TPDES	TERRITORIAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
→	LIQUID FLOW
//→	VAPOR FLOW
— —→	BY-PASS PIPING

CENTRIFUGAL PUMP

AIR BLOWER

NOTES:

1. BASED ON PRELIMINARY EVALUATIONS AND PREDICTED VOC LEVELS IN GROWNDWATER, VAPOR PHASE TREATMENT SHOULD NOT BE REQUIRED. EVALUATIONS MAY BE REQUIRED DURING THE PRE-DESIGN PHASES OF THE REMEDIAL DESIGN.

SOURCE: GERAGHTY & MILLER, INC., 1995

CDM Federal Programs Corporation
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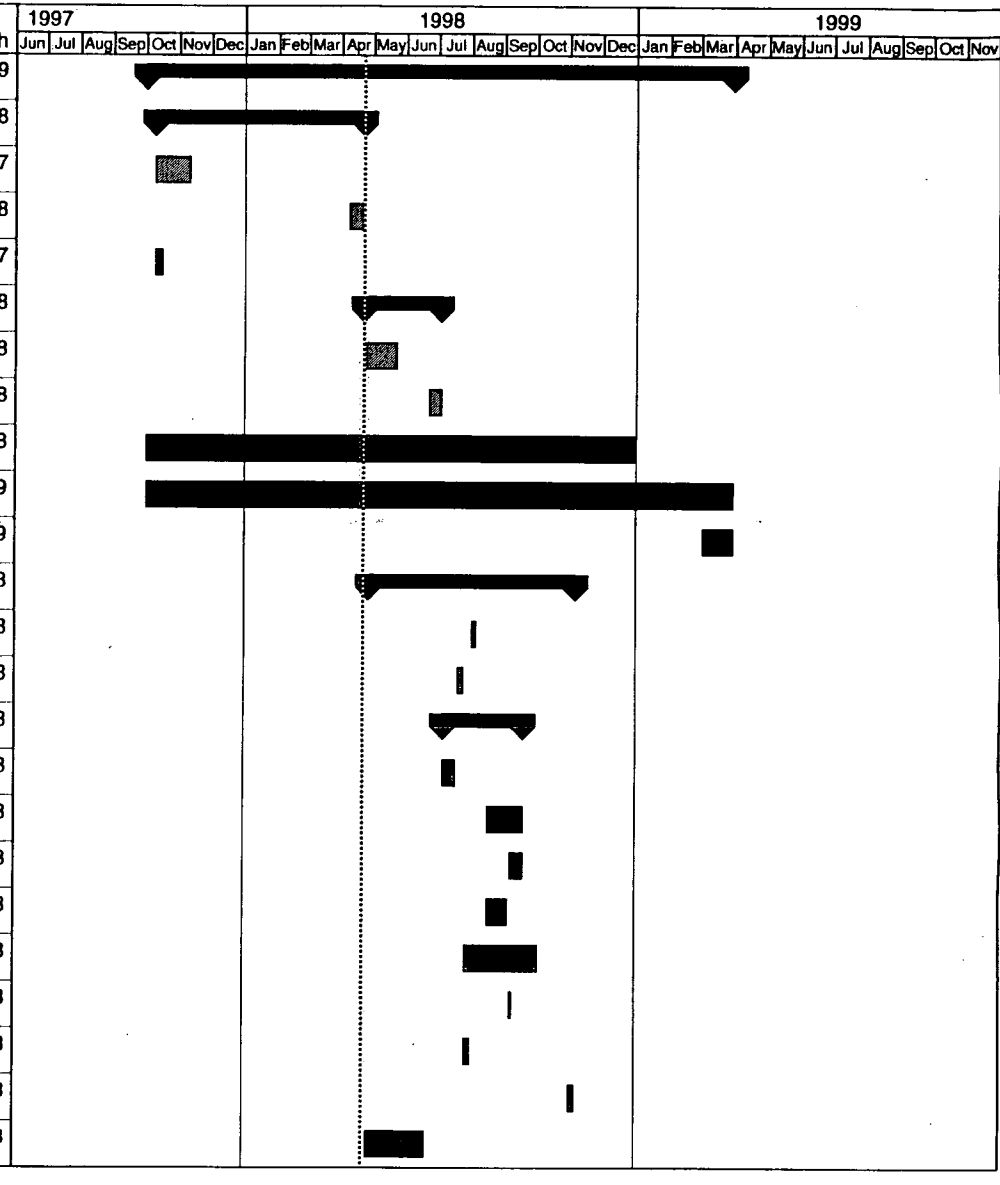
Figure No. 2

Schematic Of Groundwater Treatment Option For Discharge To Surface Water

Groundwater Remediation Design
Tutu Wells Site, St. Thomas, USVI

Tutu Wells Site - Sitewide Groundwater Remediation

ID	Name	Duration	Scheduled Start	Scheduled Finish
1	1.0 Project Planning	390d	10/1/97	3/30/99
2	WorkPlan Preparation	140d	10/9/97	4/22/98
3	Draft Work Plan	4.5w	10/9/97	11/10/97
4	Final Work Plan	2.2w	4/8/98	4/22/98
5	Review Background Documents	1w	10/9/97	10/15/97
6	Quality Assurance Project Plan	52.5d	4/22/98	7/3/98
7	Draft QAPP	4.5w	4/22/98	5/22/98
8	Final QAPP	2w	6/22/98	7/3/98
9	Quality Assurance	65w	10/1/97	12/29/98
10	Project Administration	78w	10/1/97	3/30/99
11	Project Closeout	4w	3/3/99	3/30/99
12	2.0 Pre-Design Field Investigation	140d	4/27/98	11/6/98
13	Site Reconnaissance	3d	8/2/98	8/5/98
14	Mobilization	1w	7/20/98	7/24/98
15	Hydrogeological Assessment	55d	7/6/98	9/18/98
16	Field Event 1	2w	7/6/98	7/17/98
17	Field Event 2	5w	8/17/98	9/18/98
18	Aquifer Test	2w	9/7/98	9/18/98
19	Drilling/Well Installation	3w	8/17/98	9/4/98
20	Environmental Sampling	10w	7/27/98	10/2/98
21	Geotechnical Survey	2d	9/7/98	9/8/98
22	Wetland Delineation	1w	7/27/98	7/31/98
23	Disposal of IDW	1w	11/2/98	11/6/98
24	Subcontractor Procurement	8w	4/27/98	6/19/98



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Critical
Noncritical
Progress
Milestone
Summary
Rolled Up

Figure 3

Tutu Wells Site - Sitewide Groundwater Remediation

ID	Name	Duration	Scheduled Start	Scheduled Finish
25	3.0 Groundwater Modeling	185d	5/25/98	2/5/99
26	Model develop/calibrate	4w	5/25/98	6/19/98
27	Model Application	4w	9/28/98	10/23/98
28	Draft Modeling Report	4w	10/26/98	11/20/98
29	Final Modeling Report	2w	1/23/99	2/5/99
30	4.0 Sample Analysis/DV	50d	9/21/98	11/27/98
31	Sample Management	10w	9/21/98	11/27/98
32	Data Validation	2w	11/9/98	11/20/98
33	5.0 Data Evaluation	20d	11/9/98	12/4/98
34	Eval Pre-Design Field Results	2w	11/9/98	11/20/98
35	Data Mapping	2w	11/23/98	12/4/98
36	6.0 Treatability Studies	16d	9/21/98	10/12/98
37	Bench Scale Testing	3w	9/21/98	10/9/98
38	Pilot Testing	1d	10/12/98	10/12/98
39	7.0 Discharge Options Analysis	35d	6/8/98	7/24/98
40	Draft Discharge Options Report	3w	6/8/98	6/26/98
41	Final Discharge Options Report	2w	7/13/98	7/24/98
42	8.0 Pre-Design Report	40d	1/4/99	2/26/99
43	Draft Pre-Design Report	4w	1/4/99	1/29/99
44	Final Pre-Design Report	2w	2/15/99	2/26/99
45	9.0 Remedial Design Report	105d	2/1/99	6/25/99
46	Preliminary RD (30%) Report	8w	2/1/99	3/26/99
47	Pre-Final RD (95%) Report	7w	4/12/99	5/28/99
48	Final RD (100%) Report	2w	6/14/99	6/25/99
49	Draft O&M Manual	4w	5/31/99	6/25/99

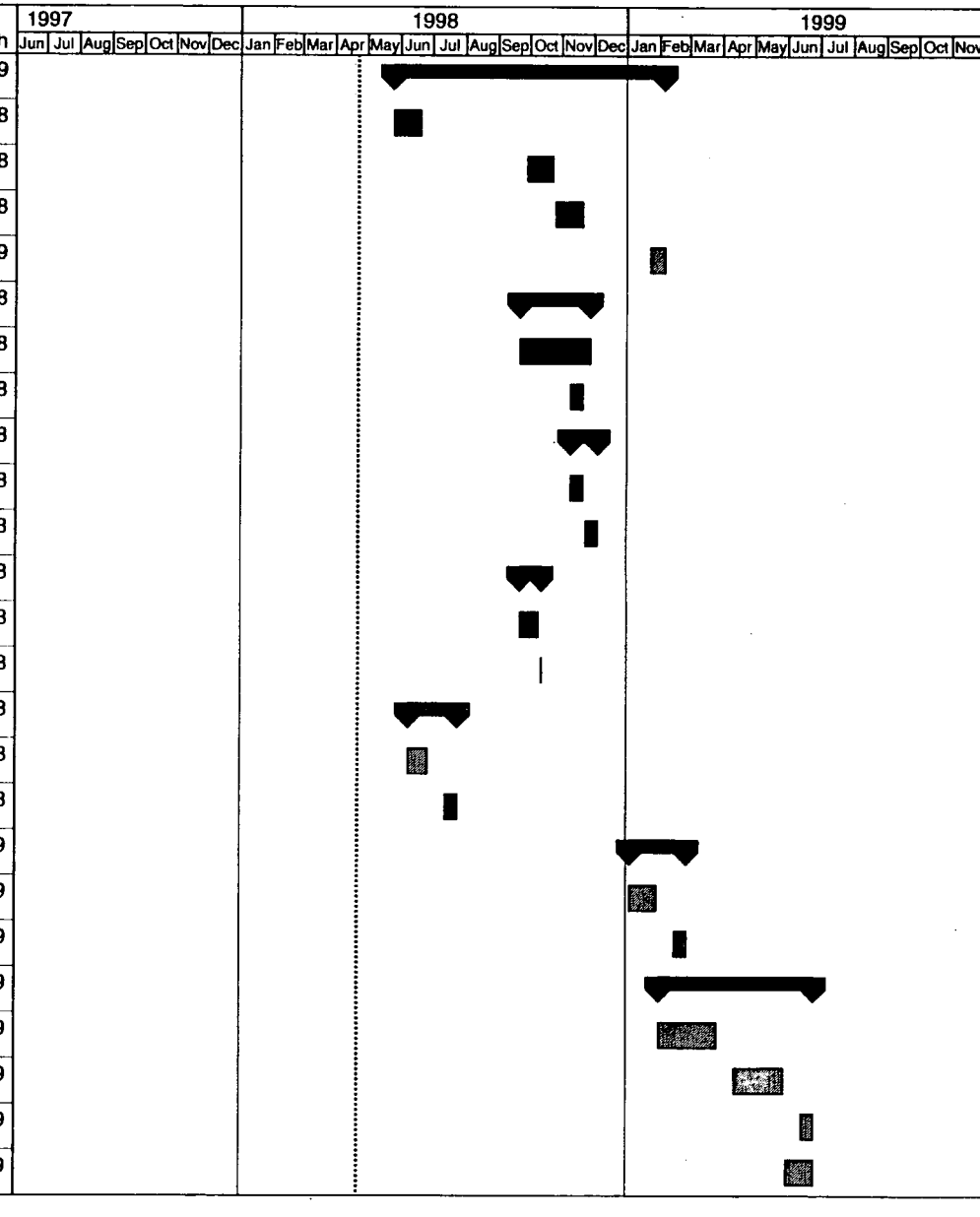

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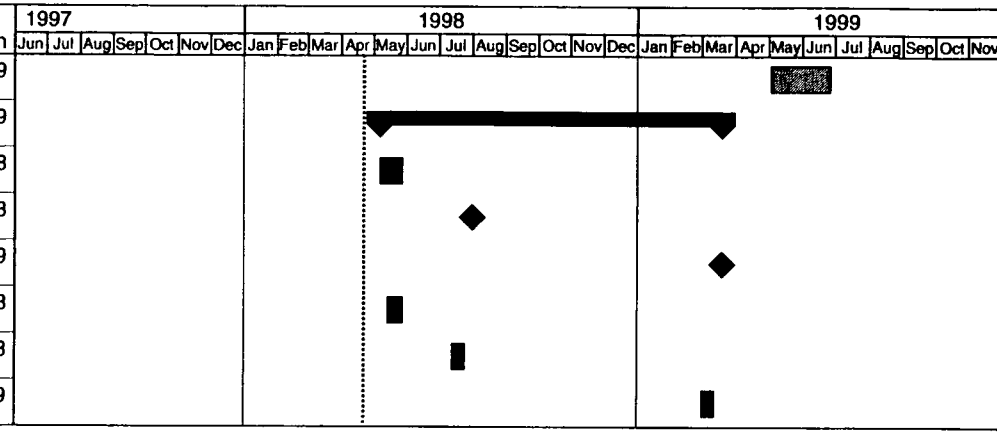
Figure 3

Tutu Wells Site - Sitewide Groundwater Remediation

ID	Name	Duration	Scheduled Start	Scheduled Finish
50	10.0 Negotiations Support	8w	5/3/99	6/26/99
51	11.0 Community Relations Support	227d	5/7/98	3/19/99
52	Revise CRP	3w	5/7/98	5/27/98
53	Public Availability Meeting 1	0d	7/31/98	7/31/98
54	Public Availability Meeting 2	0d	3/19/99	3/19/99
55	Fact Sheet 1	2w	5/14/98	5/27/98
56	Fact Sheet 2	2w	7/13/98	7/24/98
57	Fact Sheet 3	2w	3/1/99	3/12/99



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